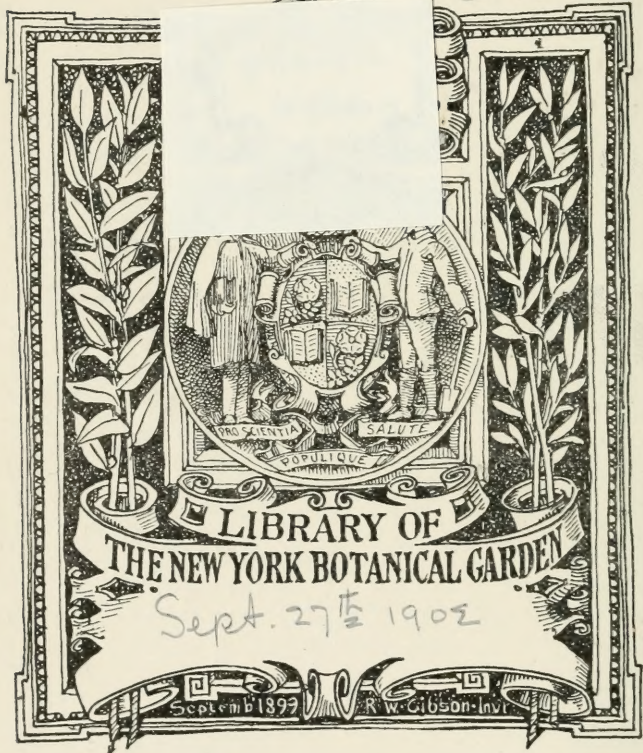


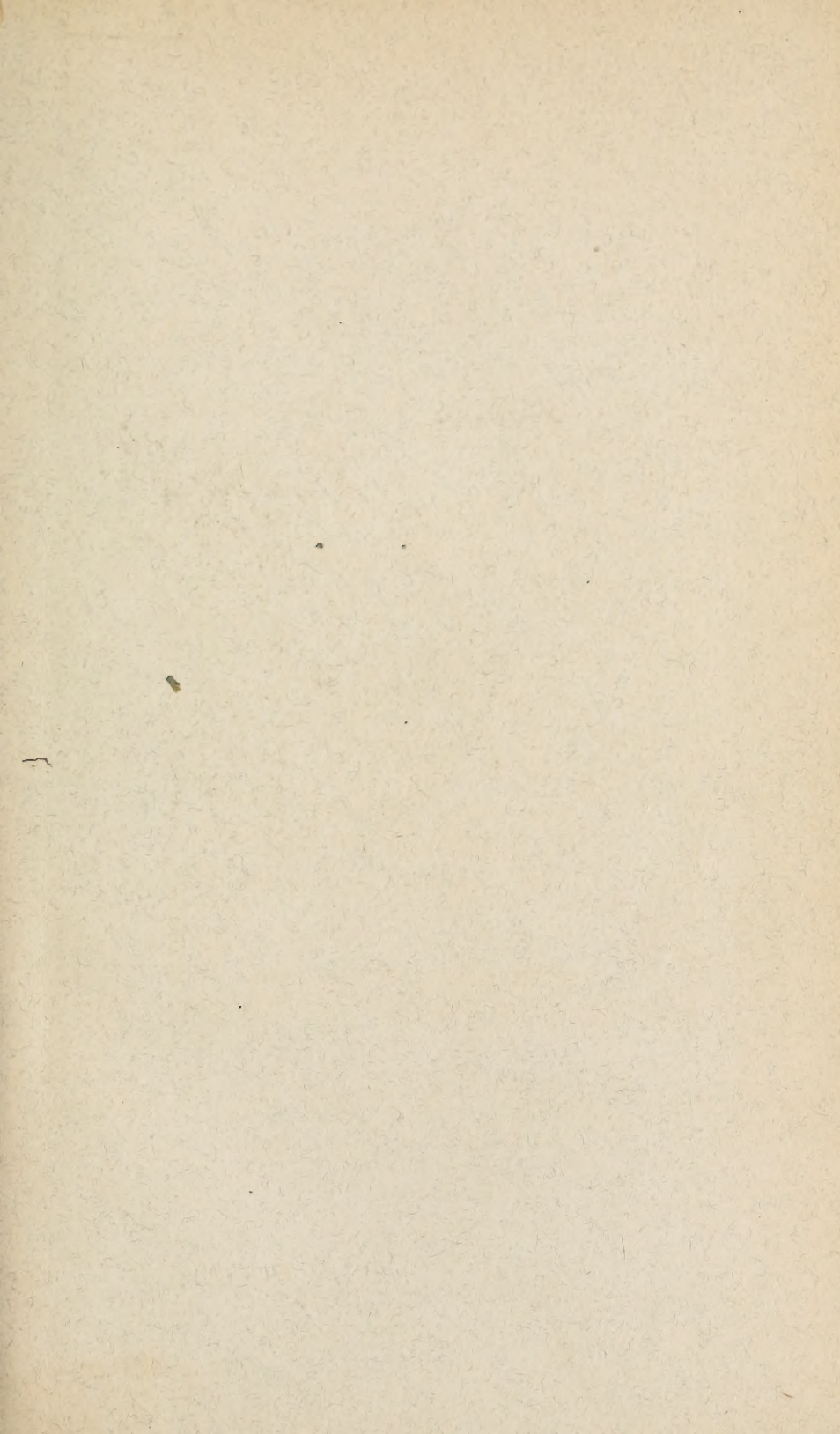




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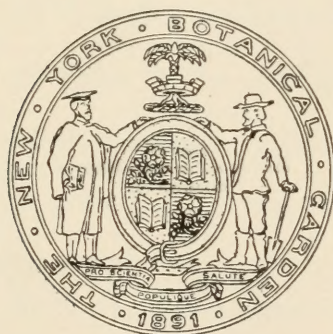
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TABLE OF CONTENTS

- 1899 No. 1. Symbiosis and Saprophytism, by Dr. D. T. MacDougal.
- 1899 No. 2. New Species from the western United States, by Dr. Per Axel Rydberg.
- 1899 No. 3. The dichotomous Panicums: some new Species, by Geo. V. Nash.
- 1899 No. 4. *Delphinium Carolinianum* and related Species, by Dr. Per Axel Rydberg.
- 1900 No. 5. Studies on the Rocky Mountain Flora—I, by Dr. Per Axel Rydberg.
- 1900 No. 6. Notes and Descriptions of North American Plants I and II, by Dr. J. K. Small.
- 1900 No. 7. Vegetative Reproduction and Multiplication in *Erythronium*, by Frederick H. Blodgett.
- 1900 No. 8. Two new Species of *Grimmia* from Montana, by R. S. Williams.
- 1900 No. 9. Studies on the Rocky Mountain Flora—II, by Dr. Per Axel Rydberg.
- 1900 No. 10. Studies on the Rocky Mountain Flora—III, by Dr. Per Axel Rydberg.
- 1901 No. 11. Life history of *Schizæa pusilla*, by Elizabeth G. Britton and Alexandra Taylor.
- 1901 No. 12. Studies on the Rocky Mountain Flora—IV, by Dr. Per Axel Rydberg.
- 1901 No. 13. Further Studies on the Potentilleae, by Dr. Per Axel Rydberg.
- 1901 No. 14. Studies on the Rocky Mountain Flora—V, by Dr. Per Axel Rydberg.
- 1901 No. 15. Studies on the Rocky Mountain Flora—VI, by Dr. Per Axel Rydberg.
- 1901 No. 16. Vanishing Wild Flowers, by Elizabeth G. Britton.
- 1901 No. 17. The Tylostomaceae of North America, by V. S. White.
- 1901 No. 18. Shrubs and Trees of the Southern States, by Dr. J. K. Small.
- 1901 No. 19. The American Species of *Limnorchis* and *Piperia*, North of Mexico, by Dr. Per Axel Rydberg.
- 1902 No. 20. The Morphology and Physiology of the Seedlings of *Arisaema triphyllum* and *A. Dracontium*, by R. J. Rennett.
- 1902 No. 21. Two new Western Mosses, by R. S. Williams.
- 1902 No. 22. Studies on the Rocky Mountain Flora—VII, by Dr. Per Axel Rydberg.
- 1902 No. 23. Studies on the Rocky Mountain Flora—VIII, by Dr. Per Axel Rydberg.
- 1902 No. 24. The Nidulariaceae of North America, by V. S. White.
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SYMBIOSIS AND SAPROPHYTISM

BY DANIEL TREMBLY MacDOUGAL

NEW YORK
1899

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB. 26: 511-530. 16 Oct., 1899]

Symbiosis and Saprophytism

BY DANIEL TREMBLY MACDOUGAL

[PLATES 367-369]

GENERAL DISCUSSION

It is customary to designate all chlorophylless seed-forming species which have no nutritive connection with other vascular plants as saprophytes, or more exactly, holosaprophytes (allotropic or heterotropic forms according to Pfeffer's classification), and others of similar physiological tendencies as hemisaprophytes (mixotropic forms), without regard to the nutritive unions formed by the roots or absorbing organs in mycorrhizas, tubercles and other associations. It is obvious that the term saprophyte, or holosaprophyte should be applied only to those species which derive their supply of food from organic products directly without the intervention of the activity of chlorophyll, and unaided by other organisms. In this sense, and it seems to the author to be the only meaning admissible, the holosaprophytes include numerous bacteria and fungi, but so far as present investigations show, only one seed-forming species, *Wulfschlaegelia aphylla*: *Cephalanthera Oregana* was erroneously grouped in this class in a previous publication.*

* An abstract of this discussion of terms was read before the Society for Plant Physiology and Morphology, at New York, Dec. 28, 1898, and was published in American Naturalist, for March, 1899 (10). See also note on same in Science for Feb. 3, 1899, and Botanical Gazette for Feb. and Sept., 1899.

As a consequence of the above limitations all species furnished with mycorrhizas, tubercles, or which enter into direct mechanical or nutritive associations must be classed as symbionts, or if it is desirable to maintain connection with existing literature dealing with these forms it would be permissible to refer to them as symbiotic saprophytes, although such designation must be regarded as tentative, and justified by expediency only (11).

It is a matter of common knowledge that seedlings are holosaprophytic in the stage in which they are wholly dependent upon the reserve material of the seed or fruit, and during the whole period previous to the formation of chlorophyll in general. This period is practically obliterated in those species in which chlorophyll is formed in the seed. On the other hand, the development of this tendency has been twofold. The increase of the capacity for the absorption of organic products has played an important part in the reduction of certain seeds to their present minute form, and again the retention, or extension, of this capacity throughout a greater or less portion of the life of the sporophyte has resulted in varying stages of true saprophytism, complete in one species of the higher plants only. The duration of the holosaprophytic stage shows very wide variations in different species. In certain arums it extends over two years under natural conditions, and may be extended by cultural methods so that the seedling may not form chlorophyll until the third or perhaps even the fourth year of existence, according to experiments now in progress. Only those species which show a marked capacity for the absorption and use of organic products during the greater part of the life of the sporophyte should be classed as hemisaprophytes. The hemisaprophytes would consist chiefly of the carnivorous plants. The greater majority of the species now included in this category are in fact more or less symbiotic by means of mycorrhizas, tubercles or other nutritive associations.

This paper describes an extension of the investigations detailed in a previous paper (11), and an effort has been made to determine whether such associations constitute a single physiological type, or whether several types of nutritive adjustment are presented.

CEPHALANTHERA OREGANA Reichenb. (13)

A number of living specimens of this plant were examined in the field in Washington and Idaho in 1892, and alcoholic material from this region was obtained in 1899. Besides the notes and material thus obtained, the author has had the opportunity of inspecting herbarium material representing the entire known range of the species, from middle California northward into British Columbia, west of the main continental divide.

The plant consists of an upright subterranean rhizome 5 to 40 cm. in length, from the internodes of which arise the adventitious roots. The internodes are provided with short sheathing scales. The aerial stem is slender, waxy white, 20 to 50 cm. long, and bears short sheathing leaves which are wholly devoid of chlorophyll. The flowers form a dense terminal raceme and perhaps agree with those of other members of the genus in being self-fertilizing (Plate 367, Fig. 1).

The seedling has not been observed. The rhizome is perennial, and the stumps of two or three old aerial stems may be seen adhering to the most recently formed internodes. Although reported from open meadows by some collectors, the author has met it only in the deep humus of coniferous forests. Its deep penetration of the loose substratum, which is generally woven together by the interlacing roots of neighboring trees, makes the collection of the entire plant very difficult and as a consequence the greater number of herbarium specimens are lacking the root system, and on none of these has the writer found the mycorrhizal rootlets described below.

THE ROOTS

The roots are wavy cylindrical organs 1.5 to 3 mm. in diameter, and from 5 to 12 cm. in length. One to four arise at each internode of the premorse rhizome, and penetrate the substratum at an angle of forty-five degrees with the horizontal. Mature organs have a yellowish-brown appearance due to the decay of the outer epidermal wall. A many-layered root-cap sheathes the tip for a distance of a millimeter, and shows a fairly normal structure. The epidermal cells are rectangular in surface section, with the radial walls separated to allow a slight outward convexity of the

outer surface, which may in some instances assume a papillose form, or may be extended to form typical root-hairs. The latter, and all of the epidermal elements, are rich in protoplasm. The outer walls of the epidermis are covered more or less thickly with crystals of calcium. The sub-epidermal layer is hardly differentiated, and consists of muriform elements rich in protoplasm, and devoid of reserve material. The cortex is composed of ovoid, cylindrical or globose cells, the outer and inner layers of which are composed of elements slightly smaller than those of the middle region. The middle and inner regions are heavily loaded with starch, especially in the older or basal portions, and the cells of the middle region show a tendency to elongation in the radius of the root. Raphide cells are indifferently distributed throughout the cortical tissues, but perhaps more abundantly in the outer layers. Two types of roots which do not differ greatly in outward aspect may be distinguished; a fibrous form, and a fleshy form about twice the diameter of the first. External to the endodermis the two are similar except in the amount of development of the cortex. In the development of the thicker storage organs, the central parenchyma becomes slightly lignified and sclerotized, the xylem bundles increase from six to seven or eight, the pericycle shows two or three layers underneath the endodermis, and this sheath is composed of slightly thickened and pitted elements with no special passage cells. The xylem and the endodermis become lignified (Plate 369, Fig. 2). In the development of the fibrous roots the xylem undergoes such centripetal development, and lateral fusion that it changes from a hexarch to a tetrach. The heavily lignified xylem and the weakly developed central parenchyma form a four-rayed star, with the phloem lodged in the sinuses (Plate 369, Fig. 2). The endodermis is heavily thickened in the regions external to the phloem regions and consists of thin-walled passage cells opposite the xylem. The xylem shows great degeneration in both types of roots, and consists of scalariform vessels and elongated tracheids with transverse pits. The phloem exhibits no great deviation from the normal, and consists of narrow sieve tubes, companion cells and some parenchyma. A layer of elongated elements containing protoplasm and apparently adapted to the conduction of proteids lies immediately outside the phloem

proper. The two types of roots show a remarkable resemblance in stelar alterations to those of the two types in *Hultschiaegelia aphylla* as described by Johow (7, p. 427), though not so distinctly separated by external characters.

The older roots often assume a dark-brown color over certain regions 6–10 cm. in length, due to the presence of an ectotropic fungus, which forms a *permanent mycelium* in three or four of the outer layers of the cortex (see page 523). The hyphae are heavy walled and septate. The inner branches form large vesicles which occupy the greater part of the cells of the medio-cortex. The outer branches of the mycelium pass through the short root-hairs into the soil. The region inhabited by the fungus gives rise to a few rootlets which assume the form of lozenge shaped branches with a length not greater than 3 cm. These branches arise endogenously, are brownish to within a few millimeters of the tips and are furnished with a well developed root cap. The mycorrhizal fungus advances toward the tips as in the branches of the *Coral-lorhiza*, and the entire structure shows an arrangement generally similar to the coralloid branches of that plant.

In the half dozen perfect specimens in the hands of the writer the branches arise only from regions inhabited by the fungus and it is conjectured that the presence of this organism may act as a stimulant in setting up such action. The fungus is found in por-

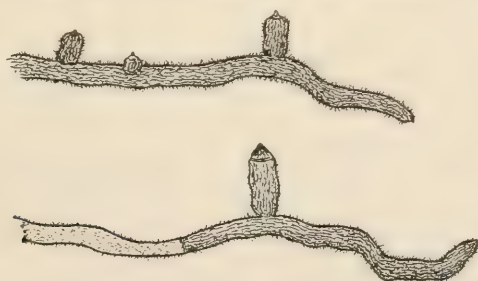


FIG. 1. Mycorrhizal portions of roots of *Cephalanthera*.

tions of the root-system 50 to 60 cm. below the surface of the soil, and as these organs are very brittle, especially the mycorrhizal portions they are generally broken off in collection. The absence of chlorophyll and mycorrhizas from numerous specimens sent in by the most careful collectors led the writer to announce that the

species was a true saprophyte (11). Recently, however, Mr. O. D. Allen, of Ashford, Washington, by special request, dug up some entire specimens with the result that the mycorrhizas were preserved, and are shown in Figure 1.

This species is noted as a parasite in systematic texts, but the author has failed to find any direct evidence of its nutritive connection with any other seed-forming species, either by his observations or from the reports of collectors.

The structural features of the roots agree with those of other mycorrhizal forms in the reduction of the absorbing surfaces, the lack of spiral and annular vessels, the formation of tracheids with narrow transverse pits and the radial elongation of the mediocortical region. This last named feature has been supposed to be due to the influence of the fungus in mycorrhizal roots, but Groom has shown that it may occur in portions of the root unoccupied by the symbiont. Its presence here, in portions of the root not occupied by the fungus, indicates that it is due to the necessities of absorption and use of organic food perhaps rather than to the stimulation of the presence of a symbiotic organism.

THE RHIZOME

The rhizome is an upright stem, slightly compressed, with internodes 1 to 2 cm. long, from the terminal internodes of which annually arise one or two flower scapes.

The epidermis is composed of elongated muriform elements with the outer walls slightly convex. No transpiratory openings are to be found. The cortex is ten to fifteen layers in thickness, the cells are ovoid, cylindrical, pitted and separated by spare intercellular spaces. The starch stored here during the resting season is usually exhausted in the formation of the inflorescence. The pericycle is two or three layers in thickness, heavily sclerotized and lignified and is interrupted in places by thin-walled elements. The crowded xylem ring contains a large number of scalariform ducts, and some imperfectly differentiated spiral and annular vessels, all deeply lignified. The phloem consists of cambiform elements with spare protoplasmic content. The interfascicular parenchyma shows collenchymatous thickenings in places, and numbers of elongated conducting cells with unlignified walls are placed near the vessels (Plate 369, Fig. 4).

The rhizome exhibits no marked or general degeneration, unless the condition of the phloem could be interpreted in this manner. The xylem is amply developed for the conduction of the supply of water necessary for the aërial shoot, and the elongated elements near the vessels appear to be suitable for the transmission for proteinaceous compounds, a function served by certain cells immediately internal to the endodermis in the root. The rhizome of *Cephalanthera* differs from similar members in symbiotic saprophytes in not being provided with organs for the excretion of water.

THE INFLORESCENCE

The flowering stem is composed of flattened internodes 2 to 5 cm. long, bearing short sheathing leaves, and a terminal raceme of flowers. The epidermis is composed of flattened cylindrical elements with oblique ends, resembling tracheids in general form, and with the inner and radial walls dotted with numerous perforations. Irregular masses, globules and networks of a yellowish brown substance are abundant in the epidermal and cortical cells of material preserved in alcohol. Ordinary chemical tests are without definite reaction, though Raspail's reagent gave slight indication of proteids in these masses. The epidermis is totally devoid of transpiratory openings.

The cortex is eight to twelve layers in thickness, and consists of elongated cylindrical elements with no intercellular spaces. It appears to serve as a tissue for the storage of water. Internal to the cortex is a sclerenchyma sheath, in the inner margin of which lies a circle of 32 to 40 bundles, and centrally placed is a second ring of six to eight bundles, which are fairly identical with those of the rhizome. Each bundle is enclosed in its own sclerenchyma sheath. The sheath and the xylem are heavily lignified. No marked degeneration is to be seen outside of the lack of chlorophyll, the transpiratory organs, and the intercellular spaces of the cortex. The heavy sclerenchyma sheath is a feature of the aërial stems of the symbiotic saprophytes. The xylem shows a very typical development.

THE LEAVES

The leaves are reduced to sheathing bracts, and are destitute of chlorophyll, as shown by an examination of the alcoholic extract

with the micro-spectroscope. The free portion representing the lamina is 1 to 2 cm. in length, and the outer dorsal surface is provided with stomata, the guard cells of which are motile and contain starch (Plate 369, Fig. 5). The possibility that the guard cells may contain a small amount of chlorophyll is not excluded, though it could not be detected by ordinary tests in the specimens examined. The epidermis is composed of muriform cells with the outer walls convex and not cuticularized. The mesophyll consists of two layers of irregularly globoid elements rich in protoplasm, and separated by large air-spaces. A third layer of thin-walled elements, cylindrical in form are to be found lateral to the simple fibrovascular bundles. This tissue is devoid of protoplasm and may serve for the storage of water. The sclerenchyma sheath is incomplete at the point of contact with this supposed storage tissue, thus permitting the ready passage of water between the xylem and the thin-walled cells.

The degeneration of the leaf is seen to consist in the loss of chlorophyll, the lack of differentiation of the mesophyll, and the reduction of the surface. This degeneration has been accompanied by the development of a tissue for the storage of water, and by the retention of the stomata. *Cephalanthera* is to be added to the list of chlorophyllless species furnished with motile stomata.

GENERAL CONSIDERATIONS

It is evident that the mycorrhiza of *Cephalanthera* is to be considered as adventitious or accidental in its occurrence. In a large number of ectotrophic forms the fungus gains entrance to the underground organ very early in its development, and then keeps pace with its growth. In this instance, however, it is found only in certain regions, and might be mistaken for a parasite were it not for its characteristic vesicles or organs of interchange. The comparatively small area of the mycorrhizal structures suggests that *Cephalanthera* is capable of absorbing largely from the humous products independently.

CALYPSO BULBOSA (L.) Oakes

The author has called attention to the occurrence of adventitious mycorrhiza in *Calypso* (11), and cited Lundström's description

of these formations, which have been found by him and others in Europe and America. Since that paper was sent to the press a shipment of plants has been received, which had been collected in northwestern United States, and a number of the specimens showed the coralloid mycorrhiza. A careful reëxamination has been made of these structures in the light of the generalizations drawn from previous material, and the results are presented below.

The subterranean stem of *Calypso* consists of an ovoid tapering corm 1.5 to 2 cm. in length, comprising two or three internodes. The single ovate, or ovate-cordate leaf is terminal, while the inflorescence arises from the first node below. The plant is reproduced vegetatively by a short offset of such reduced length that the new corm formed from its apical internodes stands upright in contact with the old corm (Plate 367, Fig. 6). The few short roots arising from the base of the corm are mycorrhizal as described in the previous paper.

STEM-MYCORRHIZA

The old or spent corms of the preceding season's activity may give rise to offsets from the basal internodes, and these may develop into coralloid structures by the repeated branching due to the development of all the buds, as in *Aplectrum*. The general anatomy of the coralloid formations is too nearly like that of the stem-mycorrhizas of *Aplectrum* to warrant description here.

The fungus is seen to be a loose skein of hyphae in the three or four outer layers of the cortex passing outwardly through the thin-walled epidermal cells into the substratum, and do not, so far as observations go, traverse through the nodal trichomes. In this respect *Calypso* differs from other coralloid plants. Occasionally small globular or ovoid structures resembling sporangioles are to be found terminating the branches of the hyphae in the outer cortex. The three or four layers of the medio-cortex are filled with dense masses of interwoven hyphae. The hyphae form irregularly swollen branches upon entering the cells of this region, and one or two of these branches near the nucleus of the cortical cell expands into a vesicle, which in turn gives off a large number of branches nearly filling the cell. The hyphae are unseptate and have definite heavy walls. The form, irregular outlines and in-

definite membranes of the hyphae in the medio-cortex led Lundström to believe that the fungus was plasmodial in its earlier stages (9). This appearance is heightened by the adhesion of the cytoplasm of the cortical cell to the hyphae. The inner cortex is free from hyphae, and contains starch in abundance, especially in the apical region. Starch is also present in the outer cortex, but quickly disappears from the cells invaded by the hyphae. The nuclei of the outer cortical cells are nearly normal, but those of the medio-cortex, occupied by the fungus, are hyperchromatic, distorted, and in some instances undergo fragmentation, as in *Peramium* (11). The stele is not differentiated into xylem and phloem, and consists chiefly of cylindrical elements rich in protoplasm, not differing greatly from plerome. The endodermis cannot be made out. The fungus of the coralloid structure and that of the roots are quite similar, but their identity is not established.

A comparison of the specimens which have come under inspection makes it apparent that the tendency to form coralloid mycorrhizas may play as important a part in *Calypso* as in *Apleticum*. The coralloid stems were small in some instances, and attached to the base of corms two years old, while in others their bulk was greater than that of the corm of the previous season to which they were attached. The extreme development was found in one specimen in which the coralloid structure was very large, and the old corm to which it was attached was shrunk to half its original size, but was still sound and normal (Plate 367, Fig. 8). A second offset had sprung from the node nearest the apex of the corm. This offset was about a centimeter in length and bore two roots at the first node while the three upper internodes had begun to swell in the formation of a new corm. The terminal portion bore a rounded cordate leaf and a flower bud. The members of this specimen named in order from the basal end were: stem-mycorrhiza, spent corm, offset, roots, developing corm, flower bud and leaf. A comparison of the specimens at hand showed a fairly well established correspondence between variation in the outline of the leaf and the development of the stem-mycorrhiza. Such variation might be due to the increased capacity of the plants furnished with coralloid structures for the absorption of humus products.

The variation in the leaf is also accompanied by increase in the length of the offsets, the decrease of the capacity of the storage organs, and the diminution in the number of the roots. The coralloid offsets of *Calypso* have not been seen to give rise to new plants as in *Aplectrum*.

The very great divergence of individuals from the type in leaf and flower characters in this species has been a subject of remark among systematists for many years, and Mr. Heller has recently raised one of the most pronounced forms to specific rank (4). Whether such variations of the shoot are directly correlated with the development of the mycorrhizal structures or not can not be definitely stated. The matter may be determined only by the careful examination of specimens in the field throughout the habitat of the species.

CORALLORHIZA ARIZONICA Wats.

(No. 94 of collection of 1898 by MacDougal.)

The general morphology, and occurrence of the fungus of the coralloid branches of *Corallorhiza* have been somewhat fully described by Schacht, Irmisch, Reinke and others, chief attention having been paid to *Corallorhiza Corallorhiza* (L.) Karst (*C. innata*). The results at hand, however, were obtained quite early in the history of investigation upon this subject, and certain details now known to be of great interest were not touched upon in these earlier researches. It was deemed advisable, therefore, to make a reëxamination of the mycorrhizal structures of another representative of the genus, with especial attention to the physiological relations of the members of the symbiotic union. Jennings and Hanna (6) have recently published a short paper on *C. innata* in which it is stated that the symbiotic fungus is a "hymenomycete and commonly an argaric." *Clitocybe infundibuliformis* Sch., was found attached to the coralloid formations in one instance, and "*Hysterangium stoloniferum* of Tulasne" in another in a manner indicative of the identity of these species with the symbiotic fungus.

Corallorhiza Arizona is a native of the upper part of the transition zone and the Canadian zone in the Rocky Mountains. The subterranean portion of the plant consists of a dense mass of coralloid stems which lie as deep as 20 cm. below the surface, and from

which extends upwardly a premorse rhizome 10 to 15 cm. in length. The thick aërial stem reaches a height of 15 to 25 cm., is sheathed by membranous leaves, and terminated by a strongly developed racemose inflorescence. The leaves and stem are irregularly colored with blotches of reddish, purplish and brownish tints, and appear to be wholly free from chlorophyll. Specimens with rudimentary aërial stems and others in bloom were collected by the writer on Mormon mountain, and on the San Francisco mountain in Arizona in 1891 and 1898, and preserved in alcohol. The results described below are based upon this material.

THE CORALLOID MYCORHIZA

The mycorhiza of this plant is a dense mass of club-shaped branches arising from the upright underground rhizome, on which the true roots are to be seen as minute papillae. The germination of the seed has not been observed, and it is impossible to say whether the primary roots are developed or not, or at what stage the symbiotic fungus invades the offsets which constitute the coralloid mass. Reinke figures a young plant, probably of the second year's growth, in which the underground member consists of a coralloid stem only (14). The external anatomy and method of branching need no further description in this species. The rhizome attains a thickness of 4 to 6 mm., with internodes 2 to 4 mm. in length.

The phloem consists of two or three layers of prosenchymatous cells with yellowish thickened walls and slimy contents, most nearly like companion cells. The phloem forms two crescents with the tips nearly touching with the 3 to 5 xylem bundles lying internally, or the phloem may form a complete ring enclosing the xylem. The xylem consists almost entirely of scalariform vessels and one or two tracheids in which the perforations are oval and elongated obliquely. The central parenchyma is made up of short cylindrical cells often richly loaded with starch. The pericycle is present as one or two layers of cambiform cells, and the endodermis forms a sheath of flattened cylindrical elements. External to the stele is a cylinder of cortical tissue 10 to 15 layers in thickness composed of ovoid or globoid elements, with large intercellular spaces, and containing starch during the resting period. The

medio-cortex is 15 to 20 layers in thickness and is composed of cells with the radial diameter twice the axial. The outer cortex consists of 3 to 5 layers of very thin-walled elements with the tangential diameter greater than the radial. Both the medio-cortex and the outer cortex are provided with intercellular spaces. The epidermis is composed of flattened cells, irregular in outline, with the lateral and inner walls pitted and the outer wall slightly thickened and brownish in color. It is furnished with a large number of stomata, with the motile guard cells of crescentic form (Plate 368, Figs. 5 and 6) containing starch. These and the large intercellular spaces constitute a very efficient aërating system, and makes the coralloid structure independent of the aërial shoot in transpiration, and at the same time allows free access of atmospheric oxygen. The apices of the rudimentary sheathing leaves are soon converted into a number of blackish shreds and their bases persist as wedge-shaped rudiments with no distinct function. Clumps of large trichomes resembling root-hairs arise from papillae which are infra-axillary to the leaves.

The fungus obtains access to the coralloid offset at quite an early stage of its existence and constantly grows toward the elongating apex forming convolutions of pale gray shining hyphae with numerous septae in the outer cortex. The growth of the hyphae keeps pace with the offset in its slow growth, and they extend forward to the shoulder of the blunt tip of each branch, curving inward at this place toward the embryonic tissue. The hyphae in the outer cortex remain active even in old mycorrhiza and may be designated as forming the permanent mycelium. The permanent mycelium is thus in the shape of a sub-epidermal cylinder, and when new branches are formed the sheathing cylinder of the fungus is continued out in it. Branches from the apical portion of the permanent mycelium penetrate the medio-cortex while it is still in an undifferentiated condition, and these branches grow and ramify with the development of the cortical cells until the latter are almost filled with their dense convolutions. For some unknown reason the development of the hyphal branches is greatest immediately internal to the nodal trichomes in the medio-cortex. The hyphal branches are generally cylindrical but occasionally portions become swollen to twice the normal diameter,

but no enlargements constituting sporangioles, vesicles or other organs of interchange are to be seen. The cortex of the younger portions of the coralloid structures is filled with starch granules which are slowly corroded by the action of the developing hyphae. Cells in which the hyphae have made many convolutions still contain some starch, but it finally disappears. The hyphae in the medio-cortex a distance from the tip are yellowish and collapsed, but no solid bodies are to be seen as a result of the liberation of their disintegration products in the cortical cells. The protoplasm of the latter is well spent but normal, and the nuclei are normal and active. The permanent mycelium sends out external branches through the trichomes into the soil. The permanent mycelium is, therefore, in the form of a sheathing cylinder with numbers of branches opposite each other extending out into the substratum and into the cortex. It is to be pointed out in this connection that the numerous statements to the effect that the fungus gains access to the interior of the coralloid structure through the trichomes are obviously incorrect. Entrance to the offset in the initial stage of the formation of the coralloid branches is perhaps made in this way, but once inside the branch the permanent mycelium is found which keeps pace with growth of the cortex and sends branches outwardly through the trichomes. The continued and repeated entrance of the fungus through the trichomes is an assumption only, and is based on the necessities of the theory of mycorrhizas as fungus traps rather than on the actual facts.

The chemotropic reactions of the fungus as shown by its method of extension are of great interest. The permanent mycelium traverses the coralloid branches in the layers of cortical tissue first differentiated. The tips of the hyphal branches are attracted out through the trichomes, presumably by atmospheric oxygen, or by the humus products, which would increase in concentration from the base of the epidermal cells to the apices of the trichomes. The attraction of the branches into the medio-cortical cells must be due to a carbohydrate, rather than a nuclear product, since it is quite noticeable that all convolutions of the hyphae are made in regions of the cell some distance from the nucleus. The tip of a hypha may pass within its own diameter of the nucleus of the cortical cell with mutual indifference, and only in a small number of in-

stances does the presence of the fungus affect the nucleus. Excretions from the hyphae cause some distortion of a few nuclei, which are also hyperchromatic. The hyphae may be traced around the cell in several circuits. Penetration of the wall and entrance into a neighboring cell is not made until the supply of starch is nearly exhausted, and the solution in the contiguous cell would form a stronger chemotropic stimulus. The portion of the hypha in the wall appears but half the normal diameter of the typical filament, and is nearly colorless even in old formations.

THE ASCENDING RHIZOME

The ascending rhizome consists of four or five napiform segments, each consisting of two or three internodes and representing one season's growth. As each segment is formed it gives rise to an inflorescence from an apical node. Later in the season it forms offsets which reproduce the premorse rhizomes with their coralloid branches. As a consequence of this mode of growth, a dozen plants may be found adherent in a colony, with the coralloid mycorrhizas closely crowded in a huge clump.

The epidermis of the rhizome consists of very irregular elements, some of which contain starch at all times. Numerous hyathodes with a central oval or oblong central cell filled with a dense mass of yellowish brown secretion, surrounded by six or seven radially arranged elements are to be seen (Plate 368, Fig. 4). The cortex shows a very copious development, consisting of ovoid or globoid elements with ample air-spaces, and embracing a large number of mucilage cells. This member is therefore furnished with a very efficient mechanism for the extrusion of water: an important provision in an organ devoted to the condensation of carbohydrates of soluble carbohydrates to starch, and this process may continue irrespective of the presence of the aerial shoot. The pericycle forms a dense heavy ring of 7 to 10 layers rich in proteids. The stele in general exhibits a degree of degeneration corresponding with that of the coralloid branches. Its parenchymatous elements as well as the cortex are loaded with starch.

THE INFLORESCENCE AXIS

The epidermis consists of flattened cylindrical cells with oblique ends, are rich in protoplasm, and entirely devoid of stomatal open-

ings. The 10 to 15 layers of cortical tissues are furnished with very large intercellular spaces, which may denote an epidermal transpiration of some importance, though no special adaptation for this purpose could be detected. Crystal cells are scattered throughout the cortex and appear even in the epidermis. The pericycle is composed of several layers of elongated cells with thickened walls and yellowish brown contents. The bundles are scattered in the stele with the xylem and phloem radially arranged. Their degeneration is fairly uniform with that of the rhizome and its branches. The leaves are sheathing, destitute of stomata, and show no differentiation of tissue for food-formation, or transpiration, except that the globular parenchyma shows great intercellular spaces. As noted above they are free from chlorophyll. *C. Arizonica* differs from *C. Corallorhiza* (*C. innata*) in the formation of a bulky premorse rhizome furnished with stomata, the total lack of chlorophyll in the shoot, with absence of stomata, and in the greater degeneration of the stele. The differentiation of the fungal symbiont into a permanent mycelium with short-lived and external and internal branches seems to be a mycorrhizal character described here for the first time, though it is present in *C. Corallorhiza* and other species. The hyphae in the coralloid formation of *C. Corallorhiza*, *C. multiflora* and others are applied to the nuclei in the cortical cell while in *C. Arizonica* this is not the case, indicating a difference of chemotropic reaction of the fungus in the two instances.

RELATIONS OF THE MYCORRHIZAL COMPONENTS

The fungus in the coralloid formations of *Corallorhiza* draws its nourishment from two sources ; from the humus products of the soil and from the carbohydrates in the cortex. The material thus obtained is used in the construction of extensions of the mycelium and its branches. With the growth and progression of the mycorrhiza, the older internal branches of the mycelium which have formed dense masses in the medio-cortex undergo disintegration and the products thus liberated may be drawn in two directions : toward the apex of the mycorrhiza and toward the premorse rhizome. On arrival at both places the surplus material is converted into starch. The starch of the rhizome is used in the construc-

tion of the reproductive and other branches. The starch in the apex of the coralloid mycorrhiza is used in the construction of embryonic tissue and a portion of it remains in the medio-cortex and becomes available to the fungus as a highly advantageous food.

Janse and others have upheld the theory that endotropic mycorrhizas are similar in physiological value to leguminous tubercles (11), but the only actual proof adduced in favor of this view is the evidence obtained by Nobbe and Hiltner from experiments with *Podocarpus* (12). That endotropic fungi may coöperate in the fixation of free nitrogen in the roots of plants in which they occupy only a portion of the absorbing system is readily admissible and may be considered as proven. Such an explanation is wholly inadequate to account for the arrangement of the mycorrhizal components and transpiratory structures in *Corallorhiza*, however, on purely anatomical grounds. The underground members of this genus are furnished with a complete sub-epidermal sheath of mycelium, which fills every cell of the outer cortex in two or three layers, except a minute area at the tip of the coralloid branch, and usually the 10 to 15 layers of the medio-cortex. It is obviously impossible for the *Corallorhiza* to absorb substances from the soil except through and by the agency of the fungus. The fungus may be capable of accomplishing the fixation of free nitrogen, but that it is not its sole, or its major function in the symbiosis, since all of the food-material of the association must pass through its hyphae; a statement equally true of such forms of ectotropic mycorrhiza as those of *Pterospora*, *Monotropa*, etc. The higher plant affords a lodgment for the fungus, from which it sends out absorbent and reproductive branches. Food-material taken in by the fungus is yielded to the higher plant and constitutes its sole supply. To this extent the higher plant is parasitic upon the fungus. But the higher plant accomplishes transformations of chemical energy in the food thus obtained of which the fungus is incapable and yields the elaborated product in an advantageous form in the apex of the mycorrhiza, where it serves as a food for the advancing mycelium. The higher plant is, therefore, not a fungus-trap pure and simple, as the association is of great mutual advantage.

The principal conclusions which may be drawn from the facts

adduced in the foregoing paper may be briefly stated as follows:

I. The term saprophyte should be applied to those species only which derive their food-supply from organic products, unaided by chlorophyll, and without the intervention of other organisms. The true saprophytes therefore include numerous bacteria, fungi and but one seed-forming species—*Wulfschlaegelia aphylla*. The saprophytic capacity of the seedling has been extended to cover periods of varying length in the life of the hemi-saprophytes and with symbiosis has reacted to diminish the tendency to store reserve material in seeds.

II. The degenerations of the true saprophytes are generally parallel to those of mycorrhizal forms.

III. *Cephalanthera Oregana* and *Corallorhiza Arizona* are to be added to the list of chlorophyllless plants furnished with stomata.

IV. The offsets of *Calypto* are occasionally converted into coralloid mycorrhizas as in *Aplectrum*. The stele of such structures is not differentiated into xylem and phloem. The occurrence of the coralloid mycorrhiza is accompanied by variations in the form of the leaves, and of the decrease in the capacity of the storage organs in the specimens examined.

V. *Corallorhiza Arizona* exhibits greater development of the symbiotic adaptation than *C. Corallorhiza*. The stele is quite primitive throughout, chlorophyll is lacking, and stomata are present on the coralloid branches only. The epidermis of the pre-morse rhizome is furnished with hyathodes. The aërial shoot is furnished with large intercellular spaces, but may carry on epidermal transpiration only. The fungus in the coralloid structures consists of a permanent mycelium, with external and internal branches; the former are organs of absorption and reproduction, the latter are organs of interchange between the members of the symbiosis. The higher plant affords lodgment for the fungus and carries on chemical transformations the products of which are available to the fungus. The latter absorbs and yields to the higher plant in a more or less complex form the products of the humous soil.

VI. All endotropic mycorrhizas do not conform to a single physiological type. The theory of Janse that endotropic fungi are negatively chemotropic to oxygen, and bear the same relation to

the higher plant as the organism of the leguminous tubercle, is not capable of general application. Such relation has been proven between *Podocarpus* and the peronosporous fungus of its mycorrhiza only.

VII. Two types of endotropic mycorrhizas may be distinguished; one adapted for nitrogen fixation, and a second for the absorption and modification—perhaps oxidation—of the soil products before liberation in the tissues of the higher plant. The extension of information will doubtless result in the further division of the second type.

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Explanation of Plates

PLATE 367. (1) Entire specimen of *Cephalanthera Oregana* Reichenb.: *A*, base of aerial stem. (2) Premorse rhizome of *Corallorhiza Arizona*: *A*, terminal bud; *B*, *B*, *B*, *B*, scars of preceding buds; *C* and *D*, offsets from which arise coralloid branches. (3, 4 and 5) Coralloid branches of *Corallorhiza Arizona*. (6) Typical specimen of *Calypto borealis*: *A*, young corm; *B*, corm of previous season's formation. (7) Aberrant specimen of *Calypto*: *A*, old corm with coralloid branch. (8) Widely aberrant form of *Calypto*: *A*, young corm; *B*, old corm with large coralloid branch, *C*.

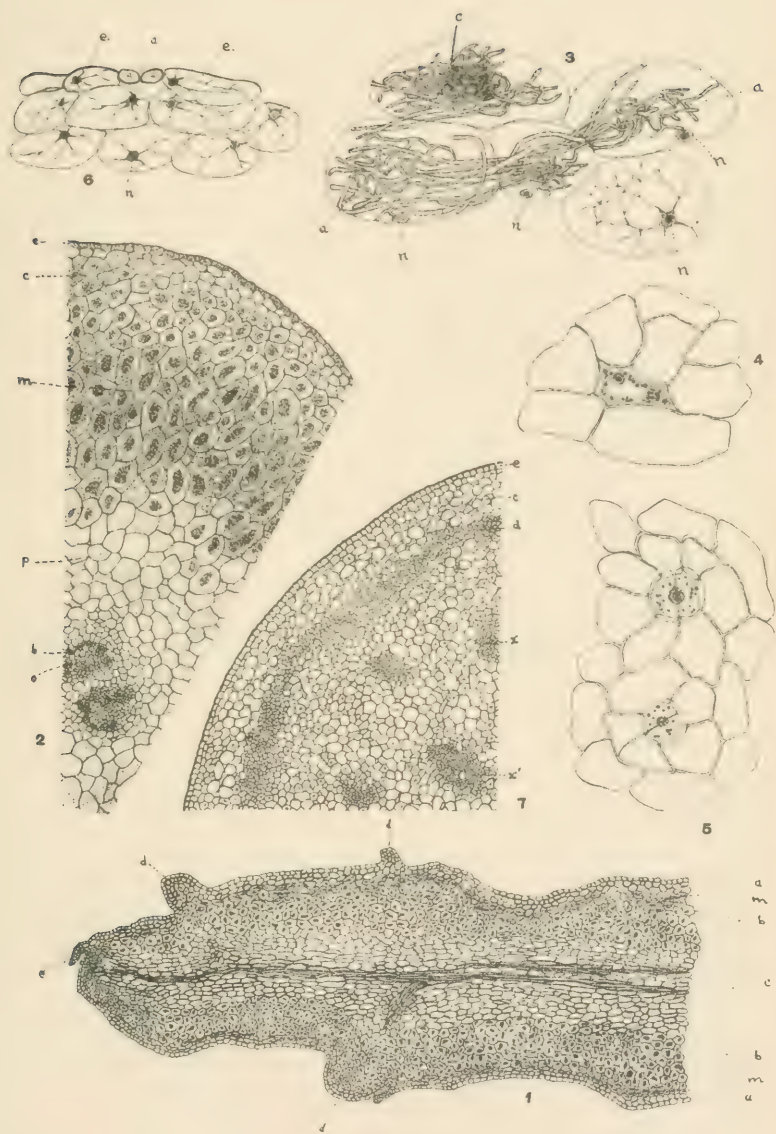
PLATE 368. *Corallorhiza Arizona* Wats. (1) Longitudinal section of tip of old coralloid mycorrhiza: *a*, *a*, epidermis; *b*, *b*, medio-cortex, containing disintegrating branches of fungus; *c*, stele; *m*, *m*, permanent mycelium; *d*, *d*, branches; *e*, leaf. (2) Portion of transverse section of mycorrhiza: *e*, epidermis; *c*, permanent mycelium; *m*, internal branches in medio-cortex; *p*, inner cortex; *b*, phloem; *o*, xylem. (3) Cells from cortex: *a*, *a*, hyphae of permanent mycelium; *c*, masses of hyphae in medio-cortical cells; *n*, *n*, *n*, nuclei of cortical cells. (4) Hyathode from premorse rhizome. (5) Stomata from coralloid branch. (6) Section of epidermis of coralloid branch showing structure of stoma: *e*, *e*, epidermal cells; *a*, guard cells; *n*, nucleus. (7) Transverse section of aerial stem: *e*, epidermis; *c*, cortex; *d*, sclerenchyma sheath; *x*, *x*, fibrovascular bundles.

PLATE 369. *Cephalanthera Oregana* Reichenb. (1) Transverse section of stele of storage root: *p*, medulla; *x*, *x*, xylem; *e*, endodermis. (2) Transverse section of stele of fibrous root: *v*, passage cells of endodermis; *e*, thickened cells of endodermis outside of phloem; *s*, phloem; *x*, xylem; *c*, medulla. (3) Longitudinal section in stele: *o*, *s*, vessels; *m*, medulla; *n*, endodermis. (4) Portion of transverse section of rhizome: *e*, epidermis; *h*, cortex; *f*, sclerenchyma sheath; *g*, fibrovascular bundles with heavy sheath; *r*, parenchyma. (5) Stoma from leaf.



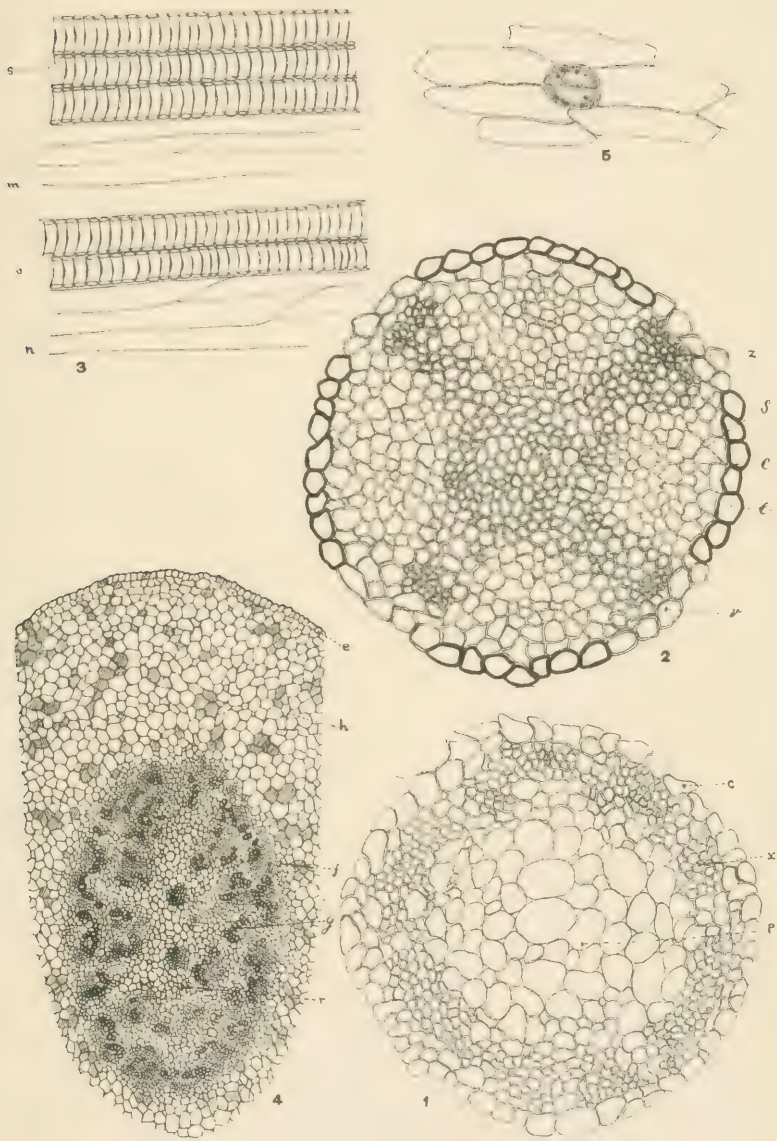
F. K. Deniston, del.

MACDOUGAL ON SYMBIOSIS.



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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 2

NEW SPECIES FROM THE WESTERN
UNITED STATES

BY P. A. RYDBERG

NEW YORK
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New Species from the Western United States

By P. A. RYDBERG

Juncus Suksdorfii

Stem about 3 dm. high, strict, light green, 2–3 mm. in diameter; leaves terete or slightly flattened, distinctly septate; the basal ones short; stem leaves, except the upper ones, often 3 dm. long all with a conspicuous, scarious sheath; heads in a contracted panicle, brown and shining, 5–8-flowered; bracts ovate, cuspidate-acuminate; perianth segments subequal, about 4 mm. long, narrowly lanceolate, acute or acuminate; stamens 6; anthers longer than the filaments; style long-exserted; capsule dark brown and shining, oblong, acuminate, 3-angled.

Dr. Watson has labeled this *Juncus Nevadensis* var., to which it may be nearest related if the structure of the flower is taken in consideration. It is different in habit, however, being much stouter, having more numerous and larger heads, and longer leaves.

WASHINGTON: Falcon Valley, 1883, *Suksdorf*, 217; 1885, 680; Spangle, Spokane Co., 1884, 464 (all in Gray Herbarium).

Allium Neo-Mexicanum

Bulb oblong, membranaceous, crowning a more or less persistent rhizome; coat membranaceous; scape slender, terete; leaves narrow, 1–3 mm. wide, apparently almost flat, slightly keeled; umbel 8–20-flowered, nodding; involucre very small; perianth-segments oblong-ovate, acute, nearly white, without a distinct mid-vein; stamens and style exserted; capsule 6-crested.

This resembles most *A. cernuum*, but differs in the fewer flowered umbel, the narrower perianth-segments, and in the thinner and narrower leaves, which are only slightly keeled.

NEW MEXICO: Organ Mountains, 1894, *E. O. Wooton*; 1851–2, *C. Wright*, 1913.

SOUTH COLORADO: 1861, *C. C. Parry*, 350.

ARIZONA: Tanners Cañon, 1892, *Dr. T. E. Wilcox*.

Astragalus Cusickii

Perennial from a creeping rootstock: stem about 5 dm. high, strigose, somewhat branched; leaves pinnate of 6–9 pairs of linear

leaflets which are 2-3 cm. long and about 2 mm. wide, glabrous above and slightly strigose beneath; raceme with a 1-2 dm. long peduncle, rather lax and few-flowered; flowers almost sessile, about 12 mm. long; calyx about 7 mm. long, strigose with dark hairs; lobes short, lanceolate and unequal; corolla yellow; pod with a stipe which is about 1 cm. long and curved upwards, upright, oblong, obcordate in cross-section, with the dorsal suture strongly inflexed to about half-way to the ventral one, subcoriaceous, the body being about 2 cm. long.

The specimens were named *A. arrectus* Gray?, to which species it has a superficial resemblance, differing in the pod, the structure of which places it near *A. Drummondii* and *A. scopulorum*. From these it differs, however, in the short erect pod. It grows on dry hillsides.

OREGON: Malheur, 1885, *W. C. Cusick*, 1238 (Gray Herbarium).

Potentilla rosulata

Glandular and viscid pubescent throughout; caudex thick and lignose, topped with dense rosettes of leaves and short stems; the latter, at least in the type specimens, less than 1 dm. high; basal leaves 4-5 cm. long, long-petioled, pinnately 5-foliolate; stem-leaves ternate, short-petioled, or the upper subsessile; lower stipules lanceolate and thin; the upper ovate and rather thick; leaflets thick, densely viscid and glandular pubescent, broadly obovate, or the terminal orbicular, deeply crenate, or somewhat cleft, 7-10 mm. long; pedicels 5-15 mm. long; hypanthium about 5 mm. in diameter, densely viscid pubescent; bractlets ovate, about half as long as the broadly triangular ovate acute or acuminate sepals; petals small, oblong, whitish or light yellow, about as long as the bractlets; stamens between 30 and 40; anthers decidedly didymous; pistils 20-40; style filiform, attached near the apex of the ovary.

This is nearest related to *Potentilla saxosa* Greene,* but differs in the less numerous leaflets of the basal leaves, the much thicker and less incised leaflets, the shorter and stouter stems, the smaller

* In my monograph I transferred this species to *Horkelia*, on account of its close resemblance to *Horkelia Baileyi*, but a study of better material in Mr. T. S. Brandegee's herbarium has persuaded me that I made a mistake. The species is a true *Potentilla*. There are three species, all belonging to the *Potentilleae*, that are almost identical in the vegetative parts, but still must be placed in three different genera. These are: *Potentilla saxosa* Greene, *Horkelia Baileyi* Wats., and *Purpusia saxosa* Brandegee.

petals and the shorter hairs of the receptacle. It resembles also *P. rivalis* somewhat in habit and leaves, but it has a thick perennial caudex, much more numerous stamens and filiform style.

CALIFORNIA: 29 Palms, Colorado Desert, 1898, *A. H. Alver-son* (type in the herbarium of *T. S. Brandegee*).

Horkelia chaetophora

Caudex stout, covered with the remains of leaf-stalks and stipules from former years; stems several, 1-1.5 dm. high, almost scapose, finely puberulent; basal leaves numerous, about 1 dm. long, with 15-20 pairs of leaflets; their stipules broad, brown, obtuse, bristly ciliate; leaflets 3-5 mm. long, divided to near the base into linear-oblong segments, densely puberulent and tipped with bristles; cyme rather many-flowered and open; hypanthium 5-7 mm. in diameter, puberulent and hirsute; bractlets linear-oblong, one third shorter than the broadly lanceolate acute sepals; petals yellow, oblong, about equaling the sepals; stamens 10; filaments filiform; pistils about 20.

This is intermediate between *H. Utahensis* and *H. pygmaea*. It resembles the former most in habit and flowers, but has the bristles and obtuse stipules characteristic to *H. pygmaea*. From the latter it differs in the larger size of the plant and flower and the many-flowered and open cyme. It grows in rocky places in the mountains at an altitude of 3000-3400 m.

CALIFORNIA: Farewell Gap and Little Kern River, Tulare Co., 1896, *C. A. Purpus*, 1409; Keweah Peak, 1895 (both in the herbarium of *T. S. Brandegee*).

Horkelia Congdonis

Perennial with a woody caudex; stems erect, 3-4 dm. high, few-leaved, somewhat branched above, glandular puberulent; basal leaves 1-1.5 dm. long, with 30-40 pairs of leaflets; stem-leaves similar but smaller; upper stipules deeply cleft; leaflets 3-5 mm. long, cleft to the base into 4-5 oblong divisions, obtuse, glandular puberulent; cyme with a few ascending branches and short-pedicelled flowers; hypanthium campanulate, 7-8 mm. in diameter, glandular puberulent; bractlets lanceolate, one half or two thirds the length of the lanceolate acuminate sepals; sepals almost equaling the sepals, oblong, obtuse; stamens 20; filaments slightly dilated, subulate; pistils numerous.

This is nearest related to *Horkelia purpurascens*, but differs in the

taller habit, the more branched cyme, the more acuminate sepals, which in the type specimens are not reflexed, and the petals, which are not retuse or emarginate as in that species.

CALIFORNIA: Casa Diabolo, 1895, *J. H. Congdon* (type in the herbarium of T. S. Brandegee).

Mertensia tubiflora

Perennial; stem 2-3 dm. high, glabrous striate, and somewhat angled, branched above; basal leaves oblanceolate, short petioled; stem-leaves sessile, lanceolate to ovate, about 4 cm. long and 1-2 cm. wide, glabrate, except the hispid ciliolate margins, muricate above, obtuse; panicle contracted; pedicels very slender and drooping, about 1 cm. long, strigulose; calyx slightly strigose, about 4 mm. long, cleft half-way into oblong-lanceolate acutish lobes; corolla 13-15 mm. long; tube about 10 mm. long and 3 mm. in diameter, more than twice as long as the limb; the latter campanulate with very short lobes; nutlets very strongly muricate.

This species combines the general habit of *M. lanceolata* with a corolla which is most like that of *M. oblongifolia*.

WYOMING: Headwaters of the Tongue River, Big Horn Mountains, July, 1898, *F. Tweedy*, 119.

Symphoricarpos Utahensis

Symphoricarpos montanus Wats. King's Exp. 5: 132 partly; not H.B. K.

Shrub a meter or more high, with brownish bark; leaves broadly ovate, more or less rounded at both ends, obtuse or often mucronate, often coarsely sinuately toothed, pubescent when young, glabrate in age, 3-4 cm. long and 2-3 cm. wide; flowers in terminal one-sided, drooping short spikes, or with smaller clusters in the upper axils; corolla somewhat funnelform, about 8 mm. long.

This resembles most *S. racemosus* in inflorescence and leaves, but differs in the form of the corolla. The inflorescence, the larger and less pubescent leaves and the size of the bush separate it from *S. rotundifolius*.

UTAH: Logan, August, 1895, *P. A. Rydberg* (Type); Wahsatch Mountain, 1869, *S. Watson*, 475, in part.*

* Watson includes under this number not less than three distinct forms. Of these one belongs to this species, one from Virginia Mountain, Nevada, to *S. oreophilus*, and the third from the Uintahs to the next or an undescribed species.

Symphoricarpus Parishii

Apparently rather tall shrub for the group ; bark of the old stems gray, of the young twigs brown ; leaves of older stems small, about 1.5 cm. long, narrowly oval, acutish at both ends, densely pubescent, more or less bluish green, rather thick ; those of the young shoots larger, about 3 cm. long, deeply 3-lobed and coarsely toothed ; corolla elongated campanulate, 6-7 mm. long.

This resembles mostly *S. rotundifolius* in pubescence and flowers, but is evidently a larger plant and the leaves are bluish green and acutish at both ends. It seems to be confined to Southern California.

CALIFORNIA : San Bernardino Mountains, 1892, *S. B. Parish*, 2514 ; 1894, 3024.

Erigeron flabellifolius

Perennial with a long slender creeping rootstock ; stem 1-2 dm. high, few-leaved, glandular puberulent above ; basal leaves petioled, about 3 cm. long, slightly glandular puberulent, cuneate-flabelliform in outline, deeply 3-5-cleft into cuneate 3-lobed divisions or the lower simply 5-9-lobed at the apex ; stem-leaves cuneate or obovate, smaller, subsessile and less divided ; heads about 10 mm. high and 10-15 mm. in diameter ; bracts linear, acuminate, with more or less spreading tips, dark brown or purplish black, glandular puberulent ; rays 7-8 mm. long and 1.5-2 mm. wide, light pink or white.

This is a member of the *E. compositum* group, easily distinguished from its relatives by the form of the leaves, which are never compound, but simply cleft two thirds their length or less. It is also characterized by the lack of hirsute pubescence generally found in that group. It grows in rocky slides at an altitude of 3600 m.

WYOMING : Yount's Peak, Teton Forest Reserve, August, 1897, *Tweedy*, 536.

Erigeron spathulifolius

Perennial from an ascending rootstock ; stems 5-8 cm. high, generally ascending, glabrous or slightly puberulent above, 3-5-leaved ; basal leaves about 2 cm. long, perfectly glabrous, somewhat fleshy, broadly spatulate, tapering into a short petiole, entire-margined, obtuse or acutish ; stem leaves 1-1.5 cm. long, linear-oblong or oblanceolate, sessile, obtuse ; head solitary, 7-8 mm. high and 10-15 mm. in diameter, excluding the rays ; bracts

linear-lanceolate, acute, black, slightly puberulent; rays light blue, in age white, about 8 mm. long and 2-3 mm. wide.

In leaves and heads, this resembles most *E. simplex* Greene, but has a different root-system, is a much more glabrous plant and lack altogether the long villous hairs on the involucre characteristic of that species. On account of its root-system, it may be associated with *E. ursinus* and *E. radicans*, but lacks the hirsute pubescence of those species and has broader rays. The same characters, together with the single head and broad leaves, separate it from *E. Eatonii*, which also has somewhat the same habit. It is an alpine species growing at an altitude of 3000 m. or more.

WYOMING: Black Rock Creek, Teton Forest Reserve, August, 1897, *Tweed*, 543.

Antennaria angustifolia

Surculose-proliferous; leaves of the stolons linear or linear-oblong, about 1.5 cm. long, finely tomentose on both sides; stem-leaves narrowly linear, erect, the uppermost subulate; heads few in a subcapitate cluster, 4-5 mm. high; involucre campanulate, tomentose at the base; bracts of the fertile head linear-oblong, acute, yellowish or brownish white.

This is nearest related to *A. parvifolia* and *A. microphylla*, from which it differs in the subcapitate heads and the very narrow leaves.

CALIFORNIA: Yosemite Valley, 1865, *J. Torrey* (labeled *A. stenophylla*?); Hat Creek, *J. S. Newberry* (labeled *A. luzuloides*; both in the Torrey Herbarium).

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 3.

THE DICHOTOMOUS PANICUMS;
SOME NEW SPECIES—I.

BY GEO. V. NASH

NEW YORK
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The dichotomous Panicums; Some new Soecies.—I

BY GEO. V. NASH

Panicum Bushii

A tufted perennial, glabrous, with the exceptions noted below. Culms about 3 dm. tall, the nodes sparingly barbed, finally much branched: leaves about 3; sheaths about as long as the internodes, those on the branches short and overlapping; ligule a dense ring of short hairs about 0.2 mm. long; blades erect, linear, acuminate, serrulate and very rough on the margins, ciliate at the base with a few very long hairs arising from papillae, the larger primary blades 8–10 cm. long, 3–4 mm. wide, those on the branches usually 6 cm. or less long; panicle much exserted, 6–7 cm. long, its branches erect-ascending, the larger 3–3.5 cm. long, the secondary panicles much smaller: spikelets 2.5 mm. long and about 1.2 mm. broad, obovate, the scales glabrous, the first scale orbicular or very broadly ovate, 1-nerved, rounded or obtuse at the apex, about one-third as long as the spikelet, the second and third scales 7-nerved, the second a little the shorter, the fourth scale yellowish white, about 2 mm. long and 1.2 mm. wide, about as long as the second.

Collected by B. F. Bush, in dry ground, in McDonald Co., Missouri, July 24, 1893 no. 413. Related to *P. angustifolium*, but the spikelets are glabrous and of a different shape and the sheaths and blades glabrous.

Panicum ciliosum

A tufted perennial. Culms 3–5 dm. tall, rather stout, ascending, papillose-hirsute with spreading hairs, finally much branched: leaves 4 or 5; sheaths shorter than the internodes, densely hirsute with spreading hairs, ciliate on the margins; ligule a dense ring of hairs about 0.5 mm. long; blades erect or ascending, narrowed toward the base, glabrous above, ciliate on the margins, the stiff hairs arising from papillae, the lower surface densely pubescent between the nerves with short spreading hairs: panicle broadly ovate, about 8 cm. long, included at the base, its axis pubescent with short hairs, the branches spreading, the larger about 3 cm. long: spikelets a trifle less than 2 mm. long and about 0.9 mm. wide, elliptic, the outer 3 scales strongly pubescent with rather long spreading hairs, the first scale broader than long, about one quarter as long as the spikelet, 1-nerved, rounded at the apex, the

second and third scales 7-nerved, about equal in length, the fourth scale white, a little longer than the third, about 1.6 mm. long and 0.8 mm. wide.

Type collected by S. M. Tracy, at Biloxi, Mississippi, September 1, 1898, no. 4580. In habit and general appearance much resembling *P. pubescens*, but the ciliate blades with the upper surface glabrous at once separate it. The specimen above described is the late state and has the panicle included; the early form of the plant will probably be found to have an exserted primary panicle.

Panicum Clutei

A tufted perennial, glabrous, with the exceptions noted below. Culms rather stout, 6-8 dm. tall, at length branched: leaves 4 or 5; sheaths rather loose, minutely pubescent at the apex and usually more or less ciliate on the exterior margin, the exterior basal ones pubescent; ligule a dense ring of hairs about 0.3 mm. long; blades firm, ascending, often appearing as if erect in pressing, lanceolate, smooth on both surfaces, rough on the margins, the lower and larger 7-14 cm. long, 7-12 mm. wide, the basal blades ovate-lanceolate, 3-4 cm. long and 10-13 mm. wide, long-ciliate on the margins: panicle considerably exserted, broadly ovate, 6-10 cm. long, its ascending branches smooth, the larger ones 4-6 cm. long: spikelets oval, acutish, about 2.3 mm. long and about 1.3 mm. wide, the first scale broadly ovate, obtuse or somewhat acute, 1-nerved, glabrous or nearly so, the second and third scales densely pubescent with very short ascending hairs, 9-nerved, the second one shorter than the third and usually a little shorter than the fourth, the fourth scale yellowish, oval, about 2 mm. long and about 1.2 mm. wide.

Pine-barrens of southern New Jersey. Collected by Mr. W. N. Clute, after whom I take pleasure in naming it, on a trip from Tuckerton to Atsion, July 3-6, 1899. A most distinct species.

Panicum curtifolium

A tufted perennial, glabrous, with the exceptions noted below. Culms slender, weak, 2-3 dm. tall, finally much branched: leaves 3 or 4; sheaths less than one half as long as the internodes, usually about one third as long, sparsely pubescent with long weak spreading hairs; ligule a dense ring of hairs about 0.3 mm. long; blades widely spreading, lanceolate, minutely serrulate and rough on the margins, a few long hairs on the upper surface just back of the ligule, the culm blades 1.5-3 cm. long, 3-4.5 mm. wide, the basal leaves 4-5 cm. long: panicle considerably exserted, broadly ovate,

2.5-3.5 cm. long, its slightly hispid branches widely spreading, the larger 1.5-2 cm. long: spikelets about 1.5 mm. long and about 0.75 mm. wide, elliptic, the scales glabrous, the first scale about one third as long as the spikelet, broadly ovate, obtuse, 1-nerved, the second and third scales 7-nerved, the second shorter than the third, the fourth scale about equalling the third, about 1.25 mm. long and about 0.6 mm. broad, yellowish-white, obscurely apiculate.

Collected by S. M. Tracy at Ocean Springs, Mississippi, May 2, 1898, no. 4598. Related to *P. lucidum* Ashe, but distinguished by its smaller spikelets and sparsely pubescent sheaths.

Panicum decoloratum

A more or less purplish tufted perennial, glabrous, with the exceptions noted below. Culms 4-6 dm. tall, stout, finally branched, the nodes barbed: leaves 5 or 6, extending to the base of the panicle, the upper one including its base; sheaths loosely embracing the culm, usually overlapping and hence concealing the culm, the lower and basal ones papillose-hirsute between the nerves, the hairs of the former early deciduous, the upper sheaths ciliate on the external margin and with a minutely pubescent ring at the apex; blades erect or ascending, variously colored with black-purple, broadly lanceolate, a little rough on both surfaces, especially above, cordate-clasping at the base, 7-12 cm. long, 1.2-2 cm. wide, minutely serrulate and very rough on the margins: panicle included at the base, its branches hispidulous: spikelets on hispidulous pedicels, 2.7 mm. long and 1.3 mm. wide, elliptic, the first scale from nearly orbicular to broadly ovate, about one third as long as the spikelet, 1-nerved, obtuse or rounded at the apex, glabrous, the second and third scales rather sparingly pubescent with ascending hairs, 9-nerved, the second scale a little shorter than the third, the fourth scale slightly yellowish-white, about 2.4 mm. long and 1 mm. wide, obtusely and rather obscurely apiculate, minutely pubescent at the apex.

Collected by Mr. E. P. Bicknell on a sandy railroad bank at Tullytown, Pennsylvania, May 30, 1899. The panicle in the material at hand may not be fully developed, and so a later stage may show it exerted instead of included at the base. In habit much resembling *P. clandestinum*, but that species is larger in every way, the pubescence is harsh and hispid and occurs on all the sheaths, the blades are much longer and with the margins near the base conspicuously ciliate with long stiff hairs, and the spikelets are larger (exceeding 3 mm. in length).

Panicum Earlei

A densely tufted perennial. Culms slender, 1-1.5 dm. tall, usually with a few long weak scattered hairs below, finally branched, the nodes rather sparingly barbed: leaves about 3; sheaths rather sparingly hirsute with long hairs; ligule a dense ring of hairs about 0.3 mm. long; blades ascending, lanceolate, rather sparingly hirsute on both surfaces with long spreading hairs, 1-3 cm. long, 2-6 mm. wide, minutely serrulate and roughened on the margins: panicle broadly ovate, 2-3 cm. long, its smooth branches spreading, the larger ones 1-1.5 cm. long: spikelets about 1.3 mm. long and 0.7 mm. wide, elliptic, obtuse, glabrous, the first scale orbicular or broadly oval, 1-nerved, obtuse, the second and third scales 7-nerved, the second scale shorter than the third and fourth, the fourth scale white, about 1 mm. long and 0.6 mm. wide, oval.

Type collected at Auburn, Lee Co., Alabama, on May 7, 1898, by Messrs. F. S. Earle and C. F. Baker, no. 1532; no. 1535, of the same place and date, also belongs here.

Panicum epilifolium

A tufted perennial, glabrous, with the exceptions noted below. Culms 2-3.5 dm. tall: leaves 2 or 3; sheaths shorter than the internodes, minutely pubescent at the apex, ciliate on both margins with long slender hairs; ligule a scarious ciliolate ring about 0.2 mm. wide; blades widely spreading, linear-lanceolate, 4-7 cm. long, 5-7 mm. wide, minutely pubescent on the upper surface between the nerves, serrulate and very rough on the margins: panicle exserted, ovate, 5-7 cm. long, its branches spreading or ascending, the larger ones 2-2.5 cm. long: spikelets 3 mm. long and about 1.5 mm. broad, oval, obtusely apiculate, the first scale glabrous or with a few scattered hairs, 1-nerved, nearly orbicular, acute, a little less than one half as long as the spikelet, the second and third scales densely pubescent with short spreading hairs, 9-nerved, the second usually a little shorter than the third and fourth, the latter scale yellowish, 2.5 mm. long and a little over 1 mm. wide, elliptic, obtusely apiculate.

Type collected by the writer in a scrub hammock at Eustis, Lake Co., Florida, March 12-31, 1894, no. 45. Also secured at the same place by Professor L. M. Underwood, on March 22, 1891, no. 2250. It bears some resemblance in habit to *P. ciliiferum*, but is readily distinguished from that species by its glabrous sheaths, naked blade-margins and more acute spikelets.

Panicum flavovirens

A densely tufted light green perennial, glabrous, with the exceptions noted below. Culms 2-3 dm. tall, slender, finally much branched: leaves 2 or 3; sheaths very short, those of the primary leaves about one third as long as the internodes, one margin usually extending above the other, making the summit of the sheath more or less oblique, the lower sheaths ciliate on the margin, the exterior basal ones pubescent all over; ligule a dense ring of short hairs about 0.2 mm. long; blades thin, erect, without a white margin or nearly so, entire or very minutely serrulate, hence smooth or nearly so on the margin, linear-lanceolate, those on the main culm 2.5-4 cm. long, 2.5-4 mm. wide, commonly minutely pubescent on the lower surface between the nerves, those on the branches much shorter, the basal blades longer, 4-6 cm. long: panicle much exserted, 3-4 cm. long, broadly ovate, its branches spreading, the larger 1-2 cm. long, the secondary panicles much smaller, barely exserted and with spreading branches: spikelets 1.5 mm. long and 0.7 mm. broad, elliptic, the outer 3 scales densely pubescent with spreading hairs, the first scale 1-nerved, broadly ovate, obtuse, about one half as long as the spikelet, the second and third scales 7-nerved, about equal in length, the fourth scale yellowish-white, 1.3 mm. long and about 0.6 mm. wide.

Type collected by the writer in Lake Co., Florida, June 16-30, 1895, no. 2061; growing in swampy woods along the edge of road leading to the ford near the J. T. & K. W. R. R. bridge across the Wekiva river. No. 2487a, collected in a similar habitat at Lake City, Columbia Co., in the same state, on Aug. 30, 1895, is also referred here.

Differs from *P. albomarginatum* in the thin linear-lanceolate blades which are entirely or almost devoid of the white margin, and barely if at all rough on the margins. In *P. albomarginatum* the blades are very thick, much broader, and with a wide strongly serrulate white margin which is much thickened.

Panicum Helleri

A tufted perennial, glabrous, with the exceptions noted below. Culms 2-4 dm. tall, appressed-pubescent below with long hairs, the nodes sparingly barbed, finally branched: leaves 5; sheaths shorter than the internodes, the middle ones only about one half as long, ciliate on the exterior margin, bearing between the prominent nerves scattered papillae, from which sometimes arise stiff

hairs, the internerves of all but the upper sheaths minutely pubescent: ligule a dense ring of hairs about 0.6 mm. long: blades broadly lanceolate, thin, a little narrowed toward the sparsely ciliate rounded base, the margins minutely serrulate, rough, 6–8 cm. long, 6–12 mm. wide: panicle included at the base, 6–8 cm. long, its branches ascending, the larger ones 3–4 cm. long, the secondary panicles smaller: spikelets 3.25–3.5 mm. long and about 1.5 mm. wide, the first scale broadly triangular-ovate, 11-nerved, the second and third scales pubescent toward the base with a few scattered hairs, the second scale 11-nerved, the third scale 9-nerved, the fourth scale yellowish-white, 2.5 mm. long and about 1.3 mm. wide, oval, obtusely and obscurely apiculate.

Collected at Kerrville, Kerr Co., Texas, by A. A. Heller, May 14–21, 1894, no. 1759. Differs from *P. pernervosum* in the pubescent culm and sheaths, the broader blades of a different shape and the narrow spikelets which are usually sparsely pubescent.

Panicum paucipilum

A tufted perennial, glabrous, with the exceptions noted below. Culms 6–10 dm. tall, finally sparingly branched: leaves 5–8; sheaths one third to one half as long as the internodes, the external margin ciliate toward the summit; ligule a dense ring of hairs about 2 mm. long: blades erect or ascending, thickish, rather firm, sometimes minutely puberulent on the lower surface, usually with a few hair-bearing papillae at the base, the lower and larger 6–9 cm. long, 5–7 mm. wide: panicle finally considerably exserted, rather dense, oblong, usually 5–10 cm. long, its branches erect-ascending or erect, the larger ones 2.5–4 cm. long: spikelets numerous, about 1.4 mm. long and 0.8 mm. wide, oval, the first scale about one third as long as the spikelet, 1-nerved, orbicular, the second and third scales pubescent with spreading hairs, the former plainly, the latter obscurely, 9-nerved, the fourth scale yellowish, about 1.3 mm. long and 0.8 mm. wide, obscurely apiculate.

In wet soil, southern New Jersey to Mississippi. Type collected by Mr. E. P. Bicknell, at Wildwood, New Jersey, May 30 and 31, 1897. The following specimens from Mississippi are also referred here:

Ocean Springs, July 19, 1889, F. S. Earle; Biloxi, Sept. 1, 1892, S. M. Tracy; Beauvoir, May 13, 1898, S. M. Tracy, no. 4594 (distributed as *P. octonodum* S. & S.).

Intermediate between *P. octonodum* and *P. Eatoni*. Differs from the former, to which it is closely related, in the ciliate margin

of the sheaths, the few basal hairs of the blades, and particularly in the strongly pubescent spikelets. From *P. Eatonii* it may be distinguished by its much smaller spikelets with the first scale glabrous and orbicular.

Panicum longiligulatum

A tufted perennial, glabrous, with the exceptions noted below. Culms 4–5 dm. tall, slender, finally branching, the branches fasciculately much divided and forming dense masses at their ends; leaves 4 or 5; sheaths usually from one third to one half as long as the internodes, minutely pubescent between the prominent nerves; ligule a ring of long erect silky hairs about 3 mm. in length; blades ascending, lanceolate, obtusely and minutely pubescent on the lower surface, the margins serrulate and very rough, the primary culm blades 2.5–3 cm. long, about 3 mm. wide, those on the branches much smaller, the basal blades thick, broadly lanceolate, 4–5 cm. long: panicle oval, 5–6 cm. long, considerably exserted, its branches spreading, the larger ones about 3 cm. long: spikelets about 1.3 mm. long and 0.8 mm. wide, oval, the outer 3 scales densely pubescent with spreading hairs, the first scale ovate, 1-nerved, about one third as long as the spikelet, the second and third scales 7-nerved, about equal in length, the fourth scale yellowish white, about 1.2 mm. long and 0.7 mm. wide.

Collected by Dr. Geo. Vasey, at Apalachicola, Florida, in 1892. Its relationship is with *P. parvispiculum*, but its more slender culms, smaller blades and spikelets and the glabrous margins of the sheaths at once distinguish it.

Panicum patentifolium

A tufted purplish perennial, glabrous, with the exceptions noted below. Culms erect or nearly so, 2–4 dm. tall, puberulent, slender, finally much branched: leaves 2–4, rather distant; sheaths less than one half as long as the internodes, minutely pubescent, especially at the apex on the margins, rather loosely embracing the culm; ligule a dense ring of hairs about 0.25 mm. long; blades widely spreading, firm, lanceolate, 2.5–4 cm. long, 2–4 mm. wide, puberulent at the very base on the upper surface, smooth on both sides, rough on the margins, the basal ones similar in shape and texture but larger: panicle at length considerably exserted, broadly ovate, 4–6 cm. long, its axis and spreading branches puberulent, the larger branches 2–3 cm. long: spikelets about 2.5 mm. long and 1.3 mm. wide, the first scale orbicular, clasping, purple, at least at the base, 1-nerved, rounded at the apex, one half as long

as the spikelet, the second and third scales pubescent with spreading hairs, 7-nerved, the fourth scale white, a little exceeding 2 mm. in length, oval, minutely pubescent at the apex.

Type collected by the writer at Eustis, Lake Co., Florida, March 12-31, 1894, no. 72, in dry sand in a scrub hammock. No. 52 of the same collection also belongs here.

Related to *P. Webberianum*, but the more slender culms and the smaller and widely spreading blades readily separate it.

Panicum perlongum

A tufted pubescent perennial. Culms 2-4 dm. tall, simple, glabrous or sparingly pubescent, the nodes barbed, later with short basal culms: leaves 1 or 2; sheaths hirsute with long ascending hairs; ligule a dense ring of hairs about 0.7 mm. long; blades elongated, linear, erect, papillose-hispid beneath, glabrous, rough above, 2-3 mm. wide, the upper blade commonly 8-14 cm. long, occasionally shorter: panicle much exserted, generally extending beyond the apex of the upper leaf, 4-6 cm. long, its branches erect or erect-ascending, the larger ones usually 2-3 cm. long: spikelets, on hispidulous pedicels, obovate, about 3.25 mm. long and 1.5-1.75 mm. wide, the outer 3 scales with a few scattered long hairs, especially near the base, the first scale one quarter to one third as long as the spikelet, orbicular-ovate, 1-nerved, the second and third scales 9-nerved, about equal in length, the fourth scale oval, 2.5 mm. long and about 1.5 mm. wide, yellowish white, obtusely apiculate, its summit reaching the apex of the third scale.

On prairies and dry soil, Illinois to North Dakota, south to Indian Territory. Type collected in Indian Territory at Creek Nation, by M. A. Carlton, April 25, 1891, no. 98, and distributed as *P. depauperatum* Muhl. It differs from that species in the smaller pubescent obtuse spikelets with the second and third scales not exceeding the fourth scale. From *P. linearifolium*, to which it is more nearly related, it is separated by its larger sparsely pubescent spikelets.

The following specimens, distributed as *P. depauperatum* Muhl., are also referred here:

ILLINOIS: June 7, 1848, *S. B. Mead*.

SOUTH DAKOTA: Custer, July 18, 1892, *P. A. Rydberg*, no.

1100.

IOWA: Ames, June 22, 1896, *C. R. Ball*, no. 145.

KANSAS: Prairie, Riley Co., 1896, *A. S. Hitchcock*, no. 881.

Panicum pernervosum

A glabrous perennial. Culms 3-5 dm. tall, finally branching: leaves 3 or 4; sheaths ciliate on the exterior margin, the lower longer, the upper shorter than the internodes; ligule a dense ring of hairs about 0.5 mm. long; blades erect or ascending, narrowed toward the base, serrulate and very rough on the margins, the intermediate and upper blades 5-10 cm. long, 5-9 mm. wide, ciliate toward the base with a few long hairs, the lower ones usually pubescent on the lower surface, shorter and broader, ciliate for two thirds their length: panicle considerably exserted, 7-12 cm. long, its branches ascending, the larger ones 4-6 cm. long: spikelets 3 mm. long and 1.8 mm. wide, broadly oval, turgid, rounded at the apex, the scales glabrous, the first scale broader than long, 1-nerved, about one third as long as the spikelet, the second and third scales coarsely 9-nerved, the second a little shorter than the third, the fourth scale yellowish white, 2.5 mm. long and about 1.6 mm. broad, obtusely and rather obscurely apiculate.

Type collected by Elihu Hall in woods, at Houston, Texas, April 16, 1872, no. 830. Mr. G. C. Nealley also secured it in the same state in 1886.

Panicum psammophilum

A tufted perennial. Culms 2-4 dm. tall, appressed-hirsute below, puberulent above, finally much branched: leaves on the main culm about 4, occasionally 3 or 5; sheaths shorter than the internodes, appressed-pubescent, the basal ones with long hairs, the upper and those on the branches with very short hairs; ligule a dense ring of hairs about 1 mm. long; blades erect or nearly so, thick, firm, serrulate on the margins, puberulent beneath, the ovate-lanceolate basal ones, and occasionally also those on the culm, with a few very long scattered erect hairs on the upper surface, the primary blades lanceolate, 2-5 cm. long, 2-5 mm. wide, those on the branches 2-3 cm. long, 2-3 mm. wide; primary panicle broadly ovate, usually 2-3 cm. long, rarely larger, its axis and usually ascending branches puberulent: spikelets broadly ob-ovate, 1.3-1.5 mm. long, rarely a little larger, and 0.8-1 mm. wide, obtuse, the outer 3 scales densely pubescent with spreading hairs, the first scale usually about one third as long as the spikelet, sometimes a little larger, 1-nerved, orbicular or broadly ovate, acute or obtuse, the second and third scales 9-nerved, the second usually a little shorter than the third, the fourth scale yellowish, 1.2-1.5 mm. long, oval.

In sandy soil, on or near the coast, Massachusetts to New Jersey. Specimens examined:

MASSACHUSETTS : Martha's Vineyard, *Miss Witman*, July, 1890 ; Ipswich, *Geo. V. Nash*, Aug. 25, 1898, no. 32.

NEW YORK : Fisher's Island, *C. B. Graves*, Aug. 29, 1898, no. 12.

NEW JERSEY : Wildwood, May 30 and 31, 1897, *E. P. Bicknell* ; Tom's River, July 25-31, 1898, *W. N. Clute*, no. 175 (type) ; Tuckerton to Atsion, July 3-6, 1899, *W. N. Clute*.

Related to *P. Addisonii*, but at once distinguished by its smaller and relatively broader spikelets.

Panicum pseudopubescens

A densely tufted pubescent perennial. Culms usually rather stout at the base, 2-4 dm. tall, hirsute with ascending hairs, finally branched, the nodes barbed : leaves usually 3 ; sheaths less than one half as long as the internodes, densely hirsute with spreading hairs 1.5-2 mm. long ; ligule a dense ring of hairs about 0.5 mm. long ; blades erect, rather firm, lanceolate, serrulate and very rough on the margins, 4-10 cm. long, 3-11 mm. wide, densely hispid on the lower surface with spreading hairs, the upper surface with a ring of long stout erect hairs just back of the ligule and usually also more or less hirsute with spreading hairs : panicle considerably exserted, broadly ovate, 5-9 cm. long, its axis glabrous or with a few scattered hairs below, the branches with the axils sparingly hirsute, ascending or spreading, the larger ones 2.5-5 cm. long : spikelets 2.25-2.5 mm. long and 1-1.2 mm. wide, obovate, a little pointed, the first scale usually about one third as long as the spikelet, 1-nerved, glabrous or sparingly pubescent, broadly ovate or nearly orbicular, acute or obtuse, the second and third scales densely pubescent with spreading hairs about 0.25 mm. long, commonly 9-nerved, the second a little shorter than the third, the fourth scale nearly white, a little less than 2 mm. long and about 1 mm. wide, oval.

Type collected at Auburn, Lee Co., Alabama, May 7, 1898, by Messrs. F. S. Earle and C. F. Baker, no. 1537. Nos. 1522, 1524, 1526 and 1529, of this same collection, are also referred here. It is distinguished from any form of *P. pubescens* by its much larger spikelets, and from *P. Atlanticum* by the shorter pubescence and stouter culms

Panicum pubifolium

P. latifolium var. *molle* Vasey, Contr. U. S. Nat. Herb. 3: 33. 1892. Not *P. molle* Sw. 1788.

P. Porterianum Nash, Bull. Torr. Bot. Club, 22: 420. In part. 1895.

A softly pubescent densely tufted perennial. Culms 3-7 dm. tall, pubescent with soft weak spreading hairs, those at the base the longer, finally branched, the nodes densely barbed with long hairs: leaves 3-5; sheaths shorter than the internodes, often only one half as long, ciliate on the margins, densely pubescent, at least all but the uppermost, with spreading weak usually long hairs, also a dense ring of short hairs at the apex; blades spreading or ascending, minutely serrulate and very rough on the margins, ovate-lanceolate to ovate, acuminate, gradually narrowed to the rounded cordate-clasping base, often inequilateral, pubescent on both surfaces with short soft spreading hairs, the upper primary blades 7-11 cm. long and 2-3 cm. broad, the lower primary blades, as well as those on the branches, smaller: primary panicle usually but little exerted, sometimes included at the base, 7-11 cm. long, its axis, as well as the branches, densely pubescent with short soft spreading hairs, the branches spreading or ascending, the larger ones 3-4 cm. long, the secondary panicles much smaller, included at the base: spikelets 4-5 mm. long and about 1.6 mm. broad, narrowly obovate, the scales distantly inserted on the rachilla, the outer 3 scales strongly pubescent with long spreading hairs, the first scale 3-nerved, from two fifths to one half as long as the spikelet, obtuse or acute, the second scale 11-nerved, the third scale 9-nerved, the former a little shorter than the latter, the fourth scale yellowish, 3.5 mm. long and 1.4-1.6 mm. broad, pubescent at the obtusely apiculate apex.

Usually in rocky woods, New York to Missouri, south to Florida and Mississippi.

Among a large number of specimens of this grass examined, the following are referred to as well representing this species:

PENNSYLVANIA: Chestnut Hill, Easton, July 1, 1887, *T. C. Porter* (distributed as *P. Walteri molle*).

DISTRICT OF COLUMBIA: Washington, June 9, 1894, *Th. Holm*, no. 14 (distributed as *P. latifolium*).

VIRGINIA: Between Fall Creek and Danville, June 3, 1891, *J. K. Small* and *A. A. Heller*, no. 466 (distributed as *P. latifolium*).

MISSOURI: McDonald Co., July 24, 1893, *B. F. Bush*, no. 415 (distributed as *P. latifolium*); Montier, June 30, 1894, *B. F. Bush*, no. 754 (distributed as *P. Walteri*).

TENNESSEE: Knox Co., July 9, 1893, *T. H. Kearney, Jr.* (dis-

tributed as *P. Walteri molle*) ; Knoxville, July, 1898, *A. Ruth*, no. 78 (distributed as *P. Porterianum*).

GEORGIA : Stone Mt., Aug. 1-6, 1895, *J. K. Small* (distributed as *P. Porterianum*).

Readily distinguished from *P. Porterianum* by the pubescent sheaths and the lower surface of the blades and the hirsute panicle.

Panicum pyriforme

A densely tufted perennial. Culms 3-4 dm. tall, rather slender, glabrous, rather weak, finally much branched ; leaves usually 2, or sometimes 3 ; sheaths much shorter than the internodes, densely papillose-hirsute with reflexed hairs ; ligule a ring of hairs about 0.3 mm. long ; blades thin, lax, glabrous on both surfaces, serrulate and very rough on the glabrous margins, long-acuminate, narrowed to the barely rounded base, 1-2 dm. long, 8-12 mm. wide, the basal ones often 2.5 dm. in length, the blades on the branches much shorter : panicle much exserted, ample, loose and open, 6-11 cm. long, its branches widely spreading, the larger ones 4-6 cm. long : spikelets rather few, about 2.5 mm. long and 1.5 mm. wide, broadly obovate, the first scale about one third as long as the spikelet, broadly triangular-ovate, 1-nerved, the second and third scales densely pubescent with long hairs, 9-nerved, the fourth scale yellowish white, about 2 mm. long and 1.5 mm. wide, oval, strongly apiculate.

Type collected by the writer in clay soil, at Orange Bend, Lake Co., Florida, March 12 31, 1894, no. 239. The larger spikelets and glabrous blades at once distinguish this from *P. laxiflorum*, to which it is otherwise related. The following numbers of my collection of 1895 are also referred here : 2034, 2156, 2531a.

Panicum strictifolium

A tufted perennial. Culms 2.5-5 dm. tall, strongly pubescent toward the base with long stiff hairs, puberulent toward the summit, finally much branched : leaves 3 or 4 ; sheaths much shorter than the internodes, the lower ones densely pubescent with long stiff appressed hairs, the upper ones more sparingly so ; ligule a dense ring of hairs about 1 mm. long ; blades erect or nearly so, rather firm, narrowly lanceolate, appressed-pubescent beneath with stiff hairs, the upper surface often with a few scattered long hairs, the lower blades also with a ring of very long stiff hairs just back of the ligule, serrulate and rough on the margins, the primary blades 4-7 cm. long, 3-5 mm. wide : panicle broadly ovate, 5-7 cm. long, its axis and spreading branches minutely pubescent, the lower

branches 2.5–3.5 cm. long: spikelets obovate, 3 mm. long and about 1.5 mm. wide, the first scale a little more than one half as long as the spikelet, broadly ovate, clasping at the base, 3-nerved, sparingly pubescent, the second and third scales densely pubescent with rather long spreading hairs, 11-nerved, the second distinctly shorter than the third and the fourth, the fourth scale yellowish-white, oval, 2.5 mm. long and about 1.3 mm. wide.

Collected by the writer in the high pine land at Eustis, Lake Co., Florida, May 3, 1894, no. 603. Most nearly related to *P. malaccon*, but distinguished by the less copious pubescence which is much finer and softer, and by the glabrous upper surface of the blades. From *P. ciliiferum* it is at once separated by its narrower blades which are not ciliate on the margins.

Panicum trifolium

A much tufted perennial, glabrous, with the exceptions noted below. Culms slender, 2–4 dm. tall, finally a little branched: leaves usually 3, rarely 4, the uppermost one much above the middle of the culm and generally but a little below the panicle; sheaths less than one half as long as the internodes, sometimes but one quarter as long: ligule a dense ring of hairs about 0.4 mm. long; blades erect or nearly so, firm, lanceolate, often minutely pubescent on the lower surface, the margins thickened and cartilaginous, serrulate and very rough, 1.5–6 cm. long, 1.5–5 mm. wide, the basal ones numerous, 4–6 cm. long: panicle more or less exserted, broadly ovate, 2.5–6 cm. long, its branches ascending, the larger ones 1.5–3 cm. long: spikelets 1.5 mm. long and about 0.7 mm. wide, elliptic, the first scale nearly orbicular, glabrous, 1-nerved, one quarter to one third as long as the spikelet, the second and third scales densely pubescent with short spreading hairs, 7-nerved, the fourth scale white, 1.3 mm. long and about 0.6 mm. wide, obtusely and obscurely apiculate.

In sandy soil, North Carolina to northern Florida, west to Mississippi. Type collected by Dr. John K. Small, in the Ocmulgee River Swamp, below Macon, Georgia, May 18–24, 1895. The following specimens are also referred here:

NORTH CAROLINA: Chapel Hill, *W. W. Ashe* (distributed as *P. ensifolium*).

SOUTH CAROLINA: Aiken, 1867, *H. W. Ravenel*.

FLORIDA: Chapman, 1890, no. 3; Apalachicola, 1892, *Dr. Geo. Vasey*.

ALABAMA: Buckley; Auburn, May 5, 1898, *Earle and Baker*, nos. 1534 and 1547a.

MISSISSIPPI: *S. M. Tracy*, Biloxi, Aug. 1, 1894, no. 2865, March 28, 1898, no. 4602, April 2, 1898, no. 4612; Avondale, April 28, 1898, no. 4610; Horn Island, June 1, 1898, no. 4613.

Related to *P. albomarginatum*, but distinguished by its thinner blades and more slender culms, which are leafy nearly to the panicle.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 4.

DELPHINIUM CAROLINIANUM AND
RELATED SPECIES

BY P. A. RYDBERG

NEW YORK
1899

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Delphinium Carolinianum and related Species

By P. A. RYDBERG

None of our native larkspurs has been more misunderstood than *Delphinium Carolinianum* Walt., or *D. azureum* Michx. This species is found in the southern states only, its northwestern limit being in Missouri. All specimens from the western states referred to it belong to one of the other species described below. Any one who has collected specimens of so-called *D. azureum* in the prairie states or in the Southwest has found trouble in trying to harmonize the specimens collected with the descriptions in our manuals. Some years ago I came to the opinion that the *D. azureum* of Nebraska and neighboring states was quite different from the *D. azureum* of the South. It is only lately, however, that I have had occasion to give closer attention to the matter, in connection with a partial revision of the Ranunculaceae of Dr. Britton's Flora. I have come to the conclusion that *D. azureum*, as treated in Gray's Synoptical Flora, contains about ten species. I regret that I have not seen mature seeds of a few of the western species, as the seeds afford excellent characters for determination.

All the species treated here have a leafy stem and seeds with a loose cellular coat, that becomes transversely rugose squamellate. The most prominent characters by which they may be distinguished from each other are the following :

Bractlets some distance below the calyx and below the thickened portion of the pedicel.

Sepals deep blue ; principal segments of the leaves cuneate, cleft nearly or quite to the middle. 1. *D. geraniifolium*.

Sepals white, tinged with blue ; segments cleft beyond the middle into narrow oblong or linear lobes.

Spur about twice as long as the petals ; sepals obovate.

Spur straight or slightly curved.

Lobes of the lateral petals not diverging ; lower pedicels not much elongated ; spur mostly horizontal. 2. *D. albescentis*.

Lobes of the lateral petals diverging ; lower pedicels elongated ; spur mostly erect. 3. *D. camporum*.

Spur strongly curved upward. 4. *D. Penardi*.

Spur thrice as long as the petals, slightly s-curved ; sepals oblong.

5. *D. macroseratilis*.

Bractlets close under the calyx on the thickened end of the pedicels.

Sepals greenish or yellowish white ; segments of the upper leaves oblong.

6. *D. virescens*.

Sepals blue or bluish ; segments of the upper leaves narrowly linear.

Plant tall, slender, green ; bractlets narrowly linear, almost subulate.

Seeds strongly wing-margined, only slightly rugose-squamellate ; raceme simple and narrow.

7. *D. Carolinianum*.

Seeds not wing-margined, strongly squamellate ; raceme often branched.

8. *D. vimineum*.

Plant low, stout, more or less canescent ; bractlets linear or lanceolate.

Sepals deep blue ; pedicels ascending.

9. *D. Geyeri*.

Sepals light blue or white, tinged with blue or purple ; pedicels erect.

10. *D. Wootoni*.

1. *Delphinium geraniifolium* sp. nov.

Stem from a deep woody perennial root, stout, 3-4 dm. high, finely grayish-strigose ; leaves numerous, especially at the base, long-petioled, grayish-strigose, mostly 5-divided to the base ; divisions cuneate, twice 2-3-cleft into broad oblong divisions ; racemes many-flowered, somewhat branched ; pedicels ascending ; bractlets linear, 2-4 mm. below the blue calyx ; spur stout, horizontal, about one half longer than the petals, slightly curved ; upper petals brownish, tipped with blue ; seeds unknown.

This is evidently nearest related to *D. Geyeri*, but differs by the broad leaf segments and the form and position of the bractlets. Dr. Gray referred it to *D. vimineum*, which it resembles very little.

ARIZONA : Charles Valley, 1883, *H. H. Rusby*.

2. *Delphinium albescens* sp. nov.

Generally tall, 3-15 dm. high, from a woody branched root, finely pubescent or glabrate below, somewhat viscid above ; leaves rather variable, from 5 to 15 cm. in diameter, repeatedly divided into linear or the lower often into oblong divisions ; raceme long and simple, sometimes 5-6 dm. long ; pedicels erect, 1-2 cm. long ; bractlets narrowly linear, borne 2-4 (in fruit often 6-8) mm. below the calyx ; sepals white with a blue spot and sometimes tinged with blue ; spur stout, about twice as long as the petals, straight or slightly curved, tinged with blue, generally horizontal or ascending ; upper petals very oblique at the summit, tinged with yellow ; the lateral ones bearded, 2-cleft, but the lobes not diverging ; follicles cylindric, pubescent ; seeds 1.5-2 mm. long, brown, sharply angled but not wing-margined, rather strongly squamellate.

This species has been included in *D. Carolinianum*, but is easily distinguished by the color of the flowers, the form and position of the bractlets, the stouter habit, and especially by the seeds. Its

distinctness from *D. camporum* is not so clear. The principal character used by Prof. Greene in order to distinguish the latter from *D. Carolinianum*, viz., the erect spur, does not hold, for *D. Carolinianum* sometimes has an erect spur; also *D. albescens*, as shown in Dr. Houghton's specimens from Lake Winnipeg. These were included by Greene in *D. camporum*, but are very unlike the plant from Texas, New Mexico and Arizona, which must be taken for the type of *D. camporum*. Houghton's plant differs in no respect, except the erect spur, from the common Larkspur of the Prairie Region. The specimens from Arkansas cited below are more slender and have narrower leaf-segments than is usual. The following specimens of *D. albescens* are found in the herbaria of the New York Botanical Garden and Columbia University.

MANITOBA: Lake Winnipeg, *Dr. Houghton*.

MINNESOTA: Hennepin Co., 1890, *J. H. Sandberg*; Fort Snelling, 1889, *E. A. Mearns*.

SOUTH DAKOTA: Scalp Creek (collector not given).

NEBRASKA: Lincoln, 1887, *H. J. Webber* (type); Crete, 1881, *G. D. Swezey*.

KANSAS: Ft. Riley, 1892, *E. E. Gayle*, 484; Atchison, 1892, *E. B. Knerr*; Riley Co., 1895, *J. B. Norton*, 8; Topeka, 1891, *B. B. Smyth*; Manhattan, 1889, *W. A. Kellerman*.

COLORADO: Ft. Collins, 1896, *C. F. Baker*.

ARKANSAS: *Dr. Pitcher*.

INDIAN TERRITORY: Sapulpa, 1895, *B. F. Bush*, 1091.

TEXAS: San Antonio, 1894, *A. A. Heller*, 1583.

MISSOURI: Eagle Rock, 1898, *B. F. Bush*, 228; Independence, 1894, 7.

ILLINOIS: Augusta, *S. B. Mead*.

3. DELPHINIUM CAMFORUM Greene, *Erythea*, 2: 183

This species is closely related to the preceding, but is generally lower and stouter, with numerous basal leaves and few stem-leaves; the lower pedicels are much elongated, often 5 cm. long; the pedicels as a rule are strongly curved at the end, bringing the spur into an erect position. The flowers are similar to those of the preceding, but generally more purely white, and the lobes of the some-

what longer lateral petals are more divergent. The upper petals are less oblique at the top. To this species, I refer the following specimens:

NEW MEXICO: Jorunda del Murto, 1851, *Geo. Thurber*, 291; Mangus Spring, 1881, *H. H. Rusby*, 5; 1852, *C. Wright*, 840.

TEXAS: Rio Bravo del Norte, 1852, *Schott*.

4. *DELPHINIUM PENARDI* Huth, *Helios*, 10: 27. 1892

I have seen no specimens of this species and from the description one would come to the conclusion that it is simply a form of *D. albescens*, the curved spur notwithstanding. We have seeds, however, received from M. E. Autran of the Boissier Herbarium, and these are very unlike those of *D. albescens*. They are large, black, very irregular, and only slightly squamellate; in fact, they are almost identical with those of *D. Geyeri*. The upper petals are also described and figured as being toothed at the apex, a condition I have never seen in *D. albescens*.

5. *Delphinium macroseratilis* sp. nov.

Stem slender, about 3 dm. high, finely grayish-pubescent; leaves divided to the base into 3-5 segments, these again 2-3-cleft; raceme simple, strict, many-flowered; pedicels erect, about 1 cm. long; bractlets 2-4 mm. below the calyx, linear; sepals white, the lower ones with a bluish spot, oblong, more than twice as long as the upper petals; spur about three times as long as the upper petals, tinged with bluish, slightly s-curved; upper petals very oblique and pointed at the summit; lateral ones much longer, 2-cleft and bearded; fruit and seeds unknown.

This is also closely related to *D. albescens*, differing in floral characters and the fewer segments of the leaves. Further study of the species is needed, especially as seeds are lacking.

TEXAS: Tom Greene Co., 1879, *Frank Tweedy*.

6. *DELPHINIUM VIRESCENS* Nutt. *Gen.* 2: 14. 1818

There is only a fragmentary specimen in the Torrey Herbarium, but this is enough to show that it is quite distinct from *D. Carolinianum*. Not only is the corolla of a different color, but it is much larger and the spur is strongly hooked at the end. The plant is much stouter than *D. Carolinianum*, stouter even than any

of the species given below. As the seeds are not known, the species may not belong to the group with squamellate seeds.

7. *DELPHINIUM CAROLINIANUM* Walt. Car. 155. 1788

D. azureum Michx. Fl. Bor. Am. 1 : 314. 1803.

D. Carolinianum is confined to the South, ranging from North Carolina, or perhaps Virginia, to Missouri and south to Florida, Louisiana and Arkansas. It is characterized by the slender habit, the small deep blue flowers, the long straight narrow raceme, the slender and slightly curved and usually horizontal spur.* The seeds are quite different from those of the related species, being smaller, only 1.5 mm. long, with broad wing-margins on the angles and only slightly squamellate on the sides. The following specimens are in the herbaria of the New York Botanical Garden and Columbia University.

GEORGIA : Augusta, 1888, *G. McCarthy*; Flint River at Albany, 1895, *John K. Small*.

FLORIDA : Jackson Co. (collector not given); *A. W. Chapman* (locality not given); West Florida, *Chapman*.

ALABAMA : *Buckley* (locality not given); Milstead, 1896, *L. M. Underwood*; Auburn, 1897, *Earle & Baker*.

MISSISSIPPI : Agency, 1897, *S. M. Tracy*.

MISSOURI : Swan, 1898, *B. F. Bush*, 188.

ARKANSAS : *Nuttall*.

8. *DELPHINIUM VIMINEUM* Don; Sweet, Brit. Fl. Gard. ser. 2, *pl.*
374

The flowers are similar to the preceding, but the plant is taller, often over a meter high, with slender lax branches. The most striking difference, however, is found in the seeds. These are scarcely angled at all, but with exceedingly strong transverse lamellae and over 2 mm. long. It is a species confined to the Gulf Region.

TEXAS : *Drummond*.

LOUISIANA : Alexandria, and Red River, *Hale*.

* The specimens from Missouri cited here have almost erect spurs.

9. *DELPHINIUM GEYERI* Greene, *Erythea*, 2: 189

This species is characterized by the strigose-canescens pubescence, the ascending instead of erect pedicels, the large blue flowers, the rather large bractlets, which often are half as long as the sepals and borne close under them. The species would not be placed in this group if it did not have squamellate seeds. These are, however, only finely so, rather large, about 3 mm. long, black, irregularly angled, but not wing-margined. The following specimens are in our herbaria:

WYOMING: Cheyenne, 1872, *E. L. Greene*; Laramie River, 1894, *Aven Nelson*, 400.

COLORADO: Fort Collins, 1896, *C. F. Baker*.

10. *Delphinium Wootoni* sp. nov.

Perennial from a deep woody root, 1.5–2 dm. high, finely grayish-strigose; basal leaves rather numerous, grayish-strigulose, rather firm, 3–5-cleft to the base, the divisions cuneate in outline, cleft beyond the middle into oblong or linear acute leaves; stem-leaves similar, very few; raceme short, rather few-flowered; pedicels erect, 1–2 cm. long; bractlets linear, close under the calyx, the latter light blue or white and tinged with blue or purple: petals white, the upper ones tinged with yellow; seeds unknown.

This is closely related to *D. albescens*, but the position of the bractlets, the grayish pubescence, the low stout habit and the firm leaves with broad segments indicate some relationship with *D. Geyeri*. In this, as in several other species, mature seeds are a desideratum.

NEW MEXICO: Organ Mountains, 1893, *E. O. Wooton* (type).

ARIZONA: Ft. Huachuca, *T. E. Wilcox*.

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STUDIES ON THE ROCKY MOUNTAIN
FLORA—I

BY P. A. RYDBERG

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Studies on the Rocky Mountain Flora.—I*

BY P. A. RYDBERG

(WITH PLATES 5 AND 6.)

SPECIES OF *SENECIO* OF THE *LOBATUS*, *AUREUS*, *SUBNUDUS* AND *TOMENTOSUS* GROUPS

It may seem strange that I present here a paper on *SENECIO*, when it is well known to me that Mr. Greenman is occupied in preparing a monograph of the genus in all North America, from the arctic regions to the Isthmus. My work was begun a year ago, and before I knew of Mr. Greenman's work. I have not been able to present my results in print before now, and I do it with the good will of the gentleman mentioned, and with the understanding that I confine myself to the Rocky Mountain region.

The four groups treated here are closely related and grade into each other. They might have been treated as a single group but even this would have been more or less artificial and ill-defined, because there are several intergradations with related groups. The more foliose species of the *AUREI* as *S. platylobus* and *S. Idahoensis* described below connect with the *EREMOPHILI*; *S. cymbalarioides* with the *ALPICOLAE*, and *S. canovirens* with the *CANI*.

The work presented here is based on my own studies in the field and the specimens found in the herbaria of the New York Botanical Garden, Columbia University and College of Pharmacy, all in New York City.

LOBATI

Annuals or biennials or perennials with a taproot, perfectly glabrous in age or slightly floccose at the bases of the leaves, more or less leafy throughout, 3 dm. or more high: leaves, all except

*The author intends to publish under this title a series of papers on the Botany of the Rocky Mountain Region. The intention is not however to limit these studies to the botany of the mountains proper, but will include also the Great Plains to the eastward. They will comprise the following states and territories: eastern British Columbia, Alberta, Saskatchewan, Assiniboia, Montana, Idaho, Wyoming, Colorado, New Mexico, eastern Utah, and the extreme western portions of the Dakotas, of Nebraska, Kansas, Oklahoma and Texas.

the very first, pinnately divided: heads rather small and minutely calyculate. In habit resembling the *AUREI* and *TOMENTOSI*, to which the last two form a transition, but have more divided leaves and a root of less duration.

Leaves thin; root annual or biennial.

Head about 1 cm. high; terminal segments of the basal leaves 3-5 cm. wide.

1. *S. sanguisorboides*.

Head 5-8 mm. high; terminal segments of the basal leaves less than 2 cm. wide.

Basal leaves with few segments; segments crenate or dentate.

2. *S. Greggii*.

Basal leaves with numerous segments; segments lobed or cleft.

3. *S. millelobatus*.

Leaves rather thick; root perennial.

Bracts thick, much shorter than the disk.

4. *S. multilobatus*.

Bracts thin, almost equaling the disk.

5. *S. Nelsonii*.

1. *Senecio sanguisorboides* sp. nov.

Tall and simple, perfectly glabrous, annual or maybe biennial: stem terete, about 6 dm. high, leafy: basal leaves thin, 1-2 dm. long, petioled, pinnately divided with 3-5 segments; terminal segments reniform, 3-5 cm. wide, coarsely crenate; lateral segments almost orbicular, crenate: lower stem leaves similar; the upper with 7-11 segments, short-petioled or the uppermost subsessile; the base of the petioles with large round, laciniate auricles; terminal segment ovate, incised-crenate; the lateral ones obovate or broadly cuneate: cyme rather contracted: heads about 1 cm. high; bracts 12-16, linear-lanceolate, acute, about 1 mm. wide, with membranous margins; the calyculate ones very few and minute, lanceolate: rays about 10, 8 mm. long and 3 mm. wide, about 4-nerved: achenes glabrous and angled.

This has been referred to *S. Sanguisorbae* DC.; but a comparison with De Candolle's description shows several discrepancies. According to the description *S. Sanguisorbae* should have only 8-10 bracts and 5 rays, the leaves should be puberulent beneath and the terminal segment orbicular, characters not found in the present species. The latter grows at an altitude of 2500-3000 m. [Plate 5, f. 14.]

NEW MEXICO: Santa Fe Cañon, 1897, *A. A. & E. Gertrude Heller*, 3820 (type in the herbarium of the N. Y. Botanical Garden); White Mountains, 1897, *E. O. Wooton*, 494.

2. *Senecio Greggii* sp. nov.

Senecio Tampicanus A. Gray, Pl. Fendl. 109. 1849; not DC., 1837; *S. lobatus* A. Gray, Pl. Wright. 2: 99. 1852; not Pers. 1807.

Biennial or annual, with several stems from the base, perfectly glabrous in age : stems about 3 dm. high : leaves pinnately divided or the very first ones simple : basal leaves with 3-5 segments, the terminal one round and crenate, about 1 cm. in diameter ; the lateral ones small, obovate ; stem leaves with 7-9 small segments and more or less auricled at the base of the very short petiole : cyme compound : heads rather many, only 5-7 mm. high ; bracts about 20, linear-acuminate ; the calyculate ones minute and few : rays 8-10, about 3 mm. long and 1.5 mm. wide, 3-nerved : achenes angled and strigose.

This is nearest related to *S. lobatus* but smaller and characterized by the many stems from the same root, the few segments of the basal leaves, the small heads and the narrow bracts. Only Wright's specimens were collected in the region here treated. [Plate 5, f. 8.]

MEXICO : Santa Rosalia, *Dr. Gregg* (type in Torrey Herbarium).

TEXAS : Near El Paso, 1851-2, *C. Wright*, 1413 ; between Frio and Nueces Rivers, 1880, *E. Palmer*, 754 ; Laredo to Frontera, *Wright* (Mexican Boundery Survey), 659, in part.

3. *Senecio millelobatus* sp. nov.

Senecio Tampicanus A. Gray, Pl. Wright. 2 : 99. 1852 ; not DC. 1837 ; *S. multilobatus* A. Gray, Syn. Fl. 1² : 394, in part. 1884 ; not T. & G. 1849.

Annual or biennial, perfectly glabrous or slightly floccose at the base of the leaves : stem branched, 3-5 dm. high, very leafy : all leaves pinnately divided, 3-7 cm. long, lanceolate or oblanceolate in outline ; segments 13-23, obovate, 3-10 mm. long, lobed or cleft into oblong or ovate lobes ; the upper segments more or less confluent : cyme compound : heads about 8 mm. high ; bracts oblong-lanceolate, acuminate, 12-15 in number ; calyculate ones minute and few : rays 5-8 mm. long and 1.5-2 mm. wide : achenes very scabrous on the angles.

This is nearest related to the preceding and to *S. lobatus* but is easily distinguished by the numerous and lobed or cleft segments. It may be related to *S. Tampicanus* which I have not seen, but that species is described as having only 4 or 5 pairs of segments and glabrous achenes. [Plate 5, f. 11.]

NEW MEXICO : Hills on the Limpia, 1851-2, *C. Wright*, 1287 (type in the Torrey herbarium) ; *P. V. Le Roy*.

TEXAS: Lower Rio Grande, 1852, *Parry* (Mexican Boundary Survey), 658.

4. *SENECIO MULTILOBATUS* Torr. & Gray; Gray, Pl. Fend. 109.
1849

The type of this species is in the Torrey herbarium and very unlike the plant regarded by Gray as *S. multilobatus*. It is characterized by its fleshy leaves and stands perhaps nearer to *S. compactus* than to the group with which it was associated by Dr. Gray. I have placed it in this group on account of its pinnatifid basal leaves. The earliest of these are, however, entire, in the same manner as they occasionally are in *S. rosulatus*. This analogy and the close relationship to *S. compactus* undoubtedly made Prof. Greene name Baker, Earle and Tracy's specimens "*Senecio compactus* Rydb., verging towards *S. Fendleri*." These specimens differ from Fremont's plant only in the fact that the basal leaves are shorter and less divided. Eastwood's specimens are exactly like the type. The base of these specimens shows that the plant is a perennial rather than an annual as stated in the original description. It grows at an altitude of about 2000 m. [Plate 6, f. 11.]

UTAH: Uintah River (a tributary of Greene River), *Fremont*, 549 (type in the Torrey herbarium); Ogden, 1871, *Hayden Survey*; South Utah, *J. E. Johnson*.

COLORADO: Grand Junction, 1892, *A. Eastwood*; Mancos, 1898, *Baker, Earle & Tracy*, 446; Dolores, 1892, *C. S. Crandall*; South Park, 1871, *W. M. Canby*.

5. *SENECIO NELSONII* Rydb. Bull. Torr. Club, 24: 483. 1899

Prof. Greene in *Pittonia*, 4: 112, devotes over a page to this species, claiming it to be the same as *S. Fendleri*, and criticises both Prof. Nelson and myself. We had, however, both investigated the matter thoroughly before the species was published. In claiming that the two species are the same, Prof. Greene must either not know one of the plants or both, or else do it for the purposes of finding fault. *S. Nelsonii* has the leaf form of *S. Fendleri*, but there ends the similarity. In the former the caudex is short, not woody, and with numerous fibrous roots, placing it nearer to *S. multilobatus* and *S. compactus*, while *S. Fendleri* has a very thick

and woody rootstock. The heads of *S. Nelsonii* are larger, 8–10 mm. high, and the bracts are thin and in anthesis almost equal the disk, while in *S. Fendleri* they are thick and much shorter. The former also lacks the fine tomentum of the latter ; it is merely floccose when young in the manner of *S. multilobatus* and *S. compactus*. *S. Nelsonii* is dark green while *S. Fendleri* is more or less yellowish. Neither of the species forms mats, as Prof. Greene states. Heller's specimens, from the type locality of *S. Fendleri*, agree fully with Gray's description of that species, except that they are more glabrate than the type. They represent a plant of several season's growth, but show nothing to indicate a matted plant. I think that Prof. Greene has here confused *S. rosulatus* with the two. Prof. Greene's conception of *S. Fendleri* must be very comprehensive, indeed, as he also includes in that such forms as *S. subcuneatus*, *S. canovirens*, and another species, nearly related to *S. fastigiatus* Nutt. This statement is founded on specimens determined by Prof. Greene only a year or two ago and found in the herbarium of the New York Botanical Garden. By comparing Plate 5, Fig. 6, and Plate 6, Figs. 1, 3, 4 and 9, with each other, one can get an idea of Prof. Greene's conception of *S. Fendleri*.

I have seen no specimens of *S. Nelsonii* except the type.

AUREI

Slender perennials, over 2 dm. high, with a short erect caudex or rootstalk, glabrous or slightly floccose when young, the wool remaining in age only at the base of the leaves : basal leaves entire, merely toothed : stem leaves more or less pinnatifid and the upper more or less reduced : heads small, cymose, with very small and few calyculate bracts.

Heads radiate.

Leaves thick, more or less fleshy.

Basal leaves narrowly oblanceolate.

Plant low, less than 2 dm. high, often with several stems from the base ;
basal leaves short-petioled.

Cyme dense ; upper leaves generally pinnatifid with narrow lobes.

6. *S. compactus*.

Cyme more open ; stem leaves entire or merely crenate.

Basal leaves subentire or 3-toothed at the apex.

7. *S. tridenticulatus*.

Basal leaves crenate.

8. *S. oblanceolatus*.

Plant about 4-6 dm. high, simple.

Leaves serrate or subentire; basal leaves 1 cm. or more, slender-petioled. 9. *S. longipetiolatus*.

Stem leaves with long, triangular lobes; basal leaves 5 cm. or less.

10. *S. fulgens*.

Basal leaves cuneate, spatulate or broadly oblanceolate, subentire at the base.

Lower stem leaves spatulate with a broad-winged petiole; upper ones sessile and with much enlarged bases. 11. *S. crocatus*.

Stem leaves neither broad-winged nor with much enlarged bases.

Basal leaves crenate above the middle. 12. *S. cymbalarioides*.

Basal leaves angularly dentate. 13. *S. Jonesii*.

Basal leaves sharply dentate or serrate above the middle.

Lower stem leaves cuneate, plant 3-4 dm. high.

14. *S. subcuneatus*.

Lower stem leaves oblanceolate; plant about 2 dm. high.

15. *S. acutidens*.

Leaves thin.

Basal leaves ovate or more commonly cordate, serrate. 16. *S. pseud aureus*.

Basal leaves obovate or oval, crenate or sinuate-dentate.

Stem leaves ovate in outline, with broad segments.

17. *S. platylobus*.

Stem leaves lanceolate or oblanceolate in outline, with narrow segments.

18. *S. flavovirens*.

Stem leaves spatulate or oblanceolate in outline, with short and broad segments.

19. *S. aurellus*.

Head discoid.

First basal leaves reniform.

20. *S. nephrophyllus*.

None of the leaves reniform.

Plant stout; stem leaves with broad lacinate segments.

21. *S. Idahoensis*.

Plant slender; stem leaves with narrow segments.

Plant yellowish or light green; bracts not purple-tinged.

17. *S. flavovirens*.

Plant dark green.

Basal leaves crenate; head 8-10 mm. high; bracts purple-tinged, linear.

22. *S. pauciflorus*.

Basal leaves wavy; heads about 6 mm. high; bracts broadly lanceolate or oblong, not purple-tinged.

23. *S. fedifolius*.

6. *SENECIO COMPACTUS* (A. Gray) Rydb. Mem. Torr. Club, 5: 342. 1893

Senecio aureus var. *compactus* A. Gray, Syn. Fl. 1²: 391. 1884.

Dr. Gray's description covers two if not three species. For which of these *S. compactus* should be used is a matter of question. I have adopted it for the plant of the plains with a dense cyme and usually pinnatifid-dentate stem leaves. Dr. Gray evidently had this plant in mind when he adopted the name *com-*

pactus. The description seems to indicate mostly this species, which also I had in mind when I raised the variety to specific rank and it is this that is described and figured in Britton and Brown's Illustrated Flora. On the other hand if synonymy and the citation of specimens are taken in consideration, the name may have been applied to the next, for the first synonym and the first specimen cited belong to that species. [Plate 5, f. 15.]

NEBRASKA : Valentine, *J. M. Bates*, 34; Lewellen, *G. D. Swcezey*, 82; Fort Niobrara, 1888, *T. E. Wilcox*; Thedford, 1893, *P. A. Rydberg*, 1311; Platte Bottom, 1891, 211.

COLORADO : Plains, 1882, *Allen & Brewster*; Colorado Springs, 1892, *Isabel Mulford*.

7. *Senecio tridenticulatus* sp. nov.

Senecio aureus var. *borealis* A. Gray, Pl. Wright. 1: 125. 1852; not T. & G. 1843; *S. aureus* var. *compactus* A. Gray, Syn. Fl. 1²: 391; in part.

Perennial with a branched caudex, in age perfectly glabrous, or slightly floccose at the base of the leaves: stems very slender, about 3 dm. high: basal leaves very narrowly oblanceolate, thick with a slender petiole, slightly 3-toothed at the apex or wholly entire, 4-8 cm. long and 4-5 mm. wide: stem leaves linear and subentire: cyme open and corymbiform: heads 7-8 mm. high: bracts lanceolate, acute $\frac{2}{3}$ or $\frac{3}{4}$ as long as the disk: rays light yellow, about 8 mm. long and 1-1.5 mm. wide, 3-nerved; achenes hispid-puberulent on the angles.

This species differs, from the preceding in the slender stem and the open cyme, and also in the form of the leaves. The latter character also separates it from the next following. It grows in wet sandy soil. The type was growing at an altitude of 2400 m. Wright's specimens are past blooming, and good characters could not be taken from them, wherefore I have made Sheldon's specimens the type. The latter were mixed with some of the next. [Plate 5, f. 12.]

COLORADO : Cottonwood Creek, Buena Vista, 1892, *C. S. Sheldon* (type in the herbarium of N. Y. Botanical Garden).

TEXAS : Mountains beyond the Limpia, 1849, *Wright*, 403.

8. *Senecio oblanceolatus* sp. nov.

Perennial with several stems from a strong root, in age glabrous or rarely slightly floccose at the base of the leaves: stems short and

stout, about 2 dm. high : basal leaves oblanceolate, thick and fleshy, 4-6 cm. long, obtuse, crenate with entire long tapering bases or the first subentire : stem leaves similar or reduced and linear in outline : cyme corymbiform, not compact : heads about 8 mm. high ; bracts linear acute, yellowish green ; the calyculate ones minute and few : rays 5-6 mm. long and about 1.5 mm. wide, 4-nerved : achenes minutely scabrous on the angles.

This species has also been included in *S. aureus compactus*, but lacks the dense inflorescence of *S. compactus* as here understood. The stem leaves never show any indication of being pinnatifid with narrow lobes as in that species. *S. compactus* is a plant of the Great Plains, while *S. oblanceolatus* is a mountain plant growing at an altitude of 1800-3000 m. [Plate 5, f. 9.]

COLORADO : Como, South Park, 1895, *C. S. Crandall* (type in the herbarium of N. Y. Botanical Garden) ; El Paso County, 1897, *A. A. & E. Gertrude Heller*, 3508 ; Cottonwood Creek, Buena Vista, 1892, *C. S. Sheldon*.

9. *Senecio longipetiolatus* sp. nov.

A tall, simple, perfectly glabrous perennial, with a short erect rootstock : stem strict, 3-6 dm. high, terete : basal leaves oblanceolate, 1-1.5 dm. long, with a slender petiole, from serrate to subentire : lower stem leaves similar ; the upper reduced, lanceolate, sessile, sharply serrate, or laciniate-dentate, often auricled at the base : cyme dense, corymbiform : heads 8-9 mm. high : bracts about 20, linear, acute : the calyculate ones few, minute, subulate and crisp : rays dark orange, 4-7 mm. long and 1.5 mm. wide, 3-4-nerved : achenes strongly angled, glabrous.

In the type the basal leaves are strongly serrate, but in the Colorado plants they are indistinctly so or subentire. Baker, Earle & Tracy's specimens were named by Professor Greene, *Senecio crocatus* Rydb. but it is entirely distinct from anything collected by Hall & Harbour, and has nothing that fits any description of *S. aureus* var. *crocus*, except the dark rays. See further remarks under *S. crocatus*. *S. longipetiolatus* grows at an altitude of 2000-3000 m. [Plate 6, f. 10, 10a.]

WYOMING : Spread Creek, Teton Forest Reserve, 1897, *F. Tweedy*, 585 (type in the herbarium of N. Y. Botanical Garden).

COLORADO : Medicine Bow Range, 1891, *C. S. Crandall* ; Hamor's Lake, north of Durango, 1898, *Baker, Earle & Tracy*, 625.

10. *Senecio fulgens* sp. nov.

Simple and glabrous perennial with a very short caudex : stem about 3 cm. high : basal leaves oblanceolate, thick and somewhat fleshy, with the petiole about 5 cm. long, dentate or subentire : lower stem leaves spatulate with a winged petiole, coarsely dentate ; upper stem leaves sessile with an auricled base, lobed with triangular or triangular lanceolate lobes, acute : cyme corymbose and rather dense : heads about 8 mm. high : bracts about 15, oblong, acute, with a broad membranous margin ; the calyculate ones few, lanceolate : achene striate, glabrous : rays 4-5 mm. long and 2 mm. wide, dark orange.

Closely related to the preceding, but differing in the short basal leaves and the lobed upper stem leaves and also in the fewer and broader bracts. It grows at an altitude of about 2700 m. [Plate 6, f. 13.]

WYOMING : Grand Creek, Teton Forest Reserve, 1897, *F. Tweedy*, 584 (type in the herbarium of N. Y. Botanical Garden).

11. *SENECIO CROCATUS* Rydb. Bull. Torr. Club, 24 : 299. 1897
Senecio aureus var. *crocus* A. Gray, Proc. Acad. Nat. Sci. Phila. 1863 : 68, 1863 ; not *S. croceus* DC. 1837.

When the above name was published I did not know that this variety of Gray's was a complex one. Hall & Harbour's no. 332, which is the type, consists of two different things ; but as one of them is rayless it can not be taken as the type of the var. *crocatus*, which was named from its orange rays. That I did not draw a new diagnosis, I admit, was perhaps careless, but this blunder I think was not worth a page and a half of discussion as it was given by Professor Greene in *Pittonia*, 4 : 114-116. I committed just the same mistake as Professor Greene himself in establishing *Antennaria media* Greene, *Pittonia*, 3 : 286. What Professor Greene says of Mr. E. Nelson in *Pittonia*, 4 : 85 can be applied to himself. Gray's description of the var. *crocus* in the Proceedings of the Philadelphia Academy is perhaps not adequate, but this description is supplemented in the Synoptical Flora and elsewhere and I think that *Senecio aureus* var. *crocus* Gray is amply published according to all rules we have. If so, *Senecio croceus* Rydberg is not a nomen nudum, whatever Professor Greene may say. Professor Greene in 1897 or 1898 accepted my name, for he named Baker, Earle &

Tracy, no. 625, *S. crocatus* Rydberg. This mistake is just as unpardonable because that plant shows none of the characters, assigned to *S. aureus* var. *crocens* Gray, except the color of the rays, and this character Professor Greene, agrees with me in regarding as of little value. That Professor Greene and other botanists may know what I now mean by *S. crocatus* I shall give a diagnosis, here following Professors Greene's example in the case of *Antennaria media*.

A glabrous perennial with a short erect rootstock : stem 1.5-3 dm. high : basal leaves 2-3 cm. long, obovate or spatulate, crenate or subentire with a winged petiole : lower stem leaves similar but with broader, winged petioles which are somewhat auricled at the base, or else oblong without distinction between blade and petiole and then more auricled : upper stem leaves ovate or triangular with very large and large-toothed auricles : cyme small and compact with 2-5 mm. heads, which are 8-10 mm. high : bracts about 20, linear : rays 7-8 mm. long and 1.5-2 mm. wide, orange to pale yellow, achenes striate, glabrous. [Plate 5, f. 13.]

COLORADO : Middle Park, 1862, *Hall & Harbour*, 332, in part (type) ; 329, in small part ; 1868, *Geo. Vasey* (Powell's Expedition), 340 B ; South Cottonwood Gulch, 1892, *C. S. Sheldon* ; Gray's Peak, 1872, *John Torrey* ; (?) Little Kate Mine, 1898, *Baker, Earle & Tracy*, 569 ; * South Park, 1871, *Canby* ; Long's Peak, 1886, *Letterman* (depauperate).

WYOMING : La Plata Mines, 1895, *Aven Nelson*, 1769.

SENECIO DIMORPHOPHYLLUS Greene, Pittonia, 4 : 109. 1900

I have not seen any specimens of this species, and have not been able to include it in the key. It is described as being a foot (about 3 dm.) high, light green and with long golden-yellow rays. Otherwise the description reads much like that given above for *S. crocatus*. The type was collected about Pagosa Peak, Colo., in 1899, by C. F. Baker.

12. SENECIO CYMBALARIOIDES Nutt. Trans. Am. Phil. Soc. II., 7 : 412. 1841

Senecio aureus borealis Torr. & Gray, Fl. 2 : 442. 1843 ; *S. aureus obovatus* Eat. King's Exp. 5 : 190, in part. 1871.

* These specimens were named *Senecio heterodoxus* Greene n. sp., but I can not find any published description. They differ from the rest in being caespitose, with less marked differentiation in the leaves and with traces of floccose pubescence at the bases of the leaves and heads. The species may be distinct.

This has sometimes orange rays and has then been confused with *S. crocatus*, but it lacks the winged petioles of the lower leaves and the large auricles of the upper. It often reaches a height of 3 dm. and then many of the stem leaves are also spatulate. Such a form with more permanent woolliness is Watson's no. 669; otherwise I cannot distinguish it from *S. cymbalarioides*. [Plate 5, f. 1.]

BRITISH AMERICA: Mackenzie River, 1861-2, *I. S. Onion*.

MONTANA: Park Co., 1887, *Tweedy*, 343, in part; Silver Bow Co., *Mrs. Moore*; Jack Creek, 1897, *Rydberg & Bessey*, 5266.

WYOMING: Beaver Cañon, 1895, *Rydberg*; Bacon Creek, 1894, *Aven Nelson*, 906.

IDAHO: Mt. Chauvet, 1897, *Rydberg & Bessey*, 5267.

UTAH: Wasatch Mts., 1869, *S. Watson*, 669.

WASHINGTON: Mt. Paddo, 1882, *W. N. Suksdorf*; Columbia, *Nuttall* (type).

13. *Senecio Jonesii* sp. nov.

A glabrous perennial: stem about 3 dm. high, slender, terete: basal leaves rounded-obovate, sinuately toothed, sometimes with a pair of small lobes at the base; their petioles often tinged with red: stem leaves oblanceolate in outline, pinnatifid with oblong segments, generally short-petioled: cyme corymbiform: heads about 8 mm. long: bracts 12-15, lanceolate, acuminate, about $\frac{2}{3}$ as long as the disk, membranous margined; calyculate ones few, linear: rays about 5 mm. long and 2 mm. wide, 4-nerved: achenes very strongly striate, glabrous.

Nearly related to the preceding, but differing in the toothing of the leaves and the form of the bracts. The type was collected at an altitude of 3300 m. [Plate 6, f. 5.]

UTAH: Alta, Wasatch Mountains, 1879, *M. E. Jones*, 1125 (type in the Columbia Herbarium).

14. *Senecio subcuneatus* sp. nov.

Perennial with a branched caudex, slightly floccose when young, glabrate in age: stems 3-4 dm. high: basal leaves about 5 cm. long, spatulate or cuneate, dentate or serrate above the middle, entire at the base and tapering into a short petiole, rather thick: lower stemleaves narrowly cuneate, short-petioled, dentate at the apex: upper ones linear and sessile, often sharply dentate: cyme corymbiform: heads about 8 mm. high: bracts about 15,

lanceolate, acute, shorter than the disk: rays 4-5 mm. long and 1.5 wide, 4-nerved: achenes striate, glabrous.

This species is nearest related to *S. cymbalarioides* but is taller, with narrower basal leaves, which have sharper teeth; the heads are also much more numerous. It grows at an altitude of 2000-2500 m. Baker, Earle and Tracy's specimens were labeled by Prof. Greene *Senecio Fendleri*, approaching *S. compactus*. This is strange from one that claims that he has known *S. Fendleri* since 1870.* This plant has little in common with that species or with *S. Nelsonii* Rydb. [Plate 5, f. 6.]

COLORADO: Grizzly Creek, 1896, *C. F. Baker* (type in the herbarium of N. Y. Botanical Garden); Lake City, 1878, *H. W. Pease* (depauperate); Mancos, 1898, *Baker, Earle & Tracy*, 63.

15. *Senecio acutidens* sp. nov.

Perennial, with a thick woody rootstock and short caudex, in age glabrate or slightly floccose at the base of the leaves: stems several, about 2 dm. high, angled, more or less tinged with red: basal leaves about 5 cm. long, thick, fleshy and somewhat glaucous, obovate or spatulate: sharply dentate above the middle, at the base entire and abruptly contracted into a slender petiole: lower stem leaves similar or oblanceolate and acute; the upper reduced, linear, laciniate-dentate or somewhat pinnatifid: cymes corymbiform and rather dense: heads 8-10 mm. high: bracts broadly linear, acute, $\frac{2}{3}$ or $\frac{3}{4}$ as long as the disk: rays about 5 mm. long and 1.5 mm. wide, 3-4-nerved: achenes slightly angled, glabrous.

Nearest related to *S. cymbalarioides* but the leaves are thicker, more glaucous and very acutely dentate. The perennial rootstock and caudex are also thicker and more woody. [Plate 5, f. 2.]

WYOMING: Union Pass, 1894, *Aven Nelson*, 858 (type in the herbarium of N. Y. Botanical Garden).

16. *SENECIO PSEUDAUREUS* Rydberg, Bull. Torr. Club, 24: 298. 1897

This is nearest related to the eastern *S. aureus* and has the same subcordate, thin, basal leaves, but these are distinctly serrate, instead of crenate. It is the most common species of the group in the Rockies, growing in wet meadows at an altitude of 1000-3000 m. [Plate 5, f. 10.]

* See Pittonia, 4: 112.

MONTANA : Little Belt Mountains, 1896, *Flodman*, 918 (type); Madison Co., *Mrs. McNulty* : Bear Gulch, 1887, *F. Tweedy*, 340 ; Columbia Falls, *Mrs. Kennedy*, 9 : Spanish Basin, 1897, *Rydberg & Bessey*, 5263 ; Indian Creek, 5264.

WYOMING : Lone Star Geyser Basin, Yellowstone Park, 1897, *Rydberg & Bessey*, 5262.

COLORADO : Grizzley Creek, 1896, *C. F. Baker* : Long's Peak, 1886, *G. W. Letterman* : Mancos, 1898, *Baker, Earle & Tracy*, 45.

NEW MEXICO : Pecos River, 8 miles east of Glorieta, 1897, *A. A. & E. Gertrude Heller*, 3682.

UTAH : E. Humbolt Mts., 1868, *S. Watson*, 667.

17. *Senecio platylobus* sp. nov.

S. aurcus var. *croccus* D. C. Eaton, King's Exp. 5 : 190, in part. 1871 ; not Gray. 1863.

A stout, perfectly glabrous perennial : stem about 4 dm. high, rather leafy, striate and somewhat angled : basal leaves 6-10 cm. long, slender-petioled, obovate or broadly oval, sinuately crenate-dentate, thin : lower stem leaves oblanceolate, petioled, deeply lobed or divided with rounded lobes : upper stem leaves broadly ovate in outline, sessile, pinnately divided into broadly oblong or cuneate divisions which are more or less deeply sinuate-dentate : cyme compound : its branches corymbiform : heads about 8 mm. high ; bracts broadly lanceolate, acute, membranous margined and slightly shorter than the disk : rays 6-7 mm. long, and 3 mm. wide, 5-nerved : achenes striate, glabrous.

Probably nearest related to the preceding, but easily distinguished by the form of the leaves and the broad rays. It grows at an altitude of about 1500 m. [Plate 6, f. 8.]

UTAH : Wasatch Mountains, 1869, *S. Watson*, 671 (type in the Torrey Herbarium).

18. *Senecio flavovirens* sp. nov.

S. Balsamitae Rydberg, Mem. N. Y. Bot. Gard., 1 : 446, mainly ; 1900 ; not Muhl. 1804.

Light or yellowish green, slender, perennial, in age glabrate or slightly floccose at the base of the leaves : stem 3-4 dm. high, striate, pale : basal leaves 3-8 cm. long, obovate or broadly oval, generally tapering into the petioles, but sometimes truncate at the bases, obtuse, crenate or sinuate, light green : lower stem leaves ob-

lanceolate in outline and petioled ; the upper lanceolate or linear in outline and sessile ; all deeply pinnatifid with narrow, oblong or linear segments : cymes contracted, corymbiform : heads 7–8 mm. high ; bracts linear, acute, yellowish-green, and occasionally with brownish tips, a little shorter than the disk ; calyculate ones few, linear, small and crisp : rays pale yellow, about 6 mm. long and 1.5 mm. wide, 4-nerved, or very often lacking : achenes hispid-puberulent on the angles.

Nearest related to the eastern *S. Balsamitae*, but characterized by its yellowish green color and a more contracted cyme. It grows at an altitude of 2000–3000 m. [Plate 5, f. 4.]

IDAHO : Beaver Cañon, 1895, *Rydberg* (type in the herbarium of N. Y. Botanical Garden).

MONTANA : Deer Lodge, 1895, *Rydberg*, 2850 (rayless) ; Helena, 1887, *F. D. Kelsey*, 501.

WYOMING : Buffalo Fork, 1897, *Tweedy*, 586 ; Laramie Plains, 1889, *E. L. Greene* (rayless) ; Green River, 1894, *Arven Nelson*, 1036 (rayless).

19. *Senecio aurellus* sp. nov.

Perennial with a short rootstock, somewhat floccose when young, soon glabrate : stem striate, 4–5 dm. high : basal leaves spatulate or cuneate, dentate-serrate, about 5 cm. long, with a short petiole, soon glabrous : lower stem leaves long-petioled, cuneate or spatulate, lyrate-lobed, the upper narrowly oblanceolate and subsessile, slightly auricled at the base : cyme compound but with rather few heads, which are about 8 mm. high : bracts 12–16, glabrous, yellowish-green, lanceolate, thin ; calyculate ones minute, lanceolate : rays golden-yellow, 5–6 mm. long and 2 mm. wide, 4-nerved : achenes scabrous hispidulous on the angles.

In the form of the stem leaves this most resembles, perhaps, *S. rosulatus*, but these are thinner and perfectly green, only slightly floccose when young. Otherwise it is intermediate between the eastern *S. Balsamitae* and *S. multilobatus*. The type was determined by Professor Greene as "*S. pseudoureus* Rydb., not typical." To that species it does not have any close relationship. [Plate 6, f. 12, 12a.]

COLORADO : Mancos, 1898, *Baker, Earle & Tracy*, 998 (type in the herbarium of New York Botanical Garden).

20. *SENECIO NEPHROPHYLLUS* Rydberg, Mem. N. Y. Bot. Garden,
1 : 446. 1900

Related to the two preceding, but characterized by the rayless heads, the reniform first basal leaves which resemble those of *Oxyria digyna*, and the pinnatifid stem leaves with their oblong blunt segments. The Colorado specimens are much lower than the type, being about 2 dm. high. [Plate 6, f. 15.]

MONTANA : Big Blackfoot River, 1883, *Canby*, 203.

COLORADO : South Park, 1872, *T. C. Porter* ; Middle Park, *Hall & Harbour*, 332, in part.

21. *Senecio Idahoensis* sp. nov.

Stout perennial, in age glabrate or slightly floccose at the base of the leaves : stem 4-5 dm. high, branched, striate, tinged with purplish : basal leaves obovate, serrate : lower stem leaves oblanceolate in outline, about 1 dm. long, petioled ; the upper ovate or lanceolate in outline, sessile and auricled at the base ; all bluish-green, pinnately divided into oblong or oblique-cuneate incised segments : heads numerous, about 1 cm. high ; bracts about 25, very narrowly linear, equaling the disk : rays none : achenes striate, glabrous.

A species somewhat related to *S. aureus*, but characterized by its broad and lacinate leaves, rayless heads and numerous very narrow bracts. [Plate 6, f. 5.]

IDAHO : Granite Station, 1892, *Sandberg, McDougal & Heller*, 803 (type in the N. Y. Botanical Garden herbarium).

22. *SENECIO PAUCIFLORUS* Pursh, Fl. Am. Sept. 529. 1814

This species, characterized by its few (2-6) rayless heads, linear purple tinged bracts, equaling the disk in length, and its small rounded-oval crenate basal leaves, has been collected several times in Labrador ; but exactly similar specimens are in the Torrey herbarium and were collected by Burke in the Rocky Mountains, but the locality is not given. [Plate 5, f. 3.]

23. *Senecio fedifolius* sp. nov.

A delicate glabrous perennial with a very short caudex and a clump of fibrous roots : stem slender, weak, about 1.5 dm high : basal leaves 3-5 cm. long with a slender petiole ; blade 1-2 cm. long, rounded-ovate or broadly oval, wavy or subentire : stem

leaves mostly small, pinnately divided into short oblong segments: heads 2-3, about 6 mm. high, somewhat turbinate; bracts 12-15, broadly lanceolate, conspicuously membranous margined: rays none: achene glabrous.

The species is named from the resemblance the basal leaves have to those of certain species of *Valerianella* which genus has also been known under the name *Fedia*. [Plate 5, f. 7.]

COLORADO: South Park, 1871, *W. M. Canby* (type in the herbarium of the College of Pharmacy, New York).

SUBNUDI

A slender perennial with a long slender horizontal rootstock, perfectly glabrous, sparingly leafy, monocephalous: basal leaves broadly obovate, coarsely crenate-dentate: heads decidedly turbinate with narrow linear-acuminate bracts; calyculate bracts, if present, few, and half as long as the main series. A single species.

24. *SENECIO SUBNUDUS* DC. Prod., 7: 428. 1837

Senecio aureus var. *subnudus* Gray, Syn. Fl. 1²: 391. 1884.

This species has been included as a variety of *S. aureus*, but I think it should be regarded as the type of a distinct group. The long slender horizontal rootstock and the decidedly turbinate involucre is not found in any of the *aureus* allies. The latter characters would place it near *S. frigidus*. [Plate 6, f. 2.]

WASHINGTON: Chiquash Mountains, 1892, *Suksdorf*, 2167; Cascade Mountains, 1882, *Brandege*, 118.

OREGON: 1882, *T. Howell*; 1871, *Elihu Hall*, 304.

CALIFORNIA: Butterfly Valley, 1874, *Mrs. R. M. Austin*.

MONTANA: Park Co., 1887, *Tweedy*, 344; Pony, 1897, *Rydberg & Bessey*, 5270.

WYOMING: Wind River, 1842, *Fremont*; Buffalo Fork, 1897, *Tweedy*, 587; Yellowstone Park, 1884, *Tweedy*, 120.

TOMENTOSI

Perennials, over 2 dm. high, with a short caudex or rootstock, which often is subliguous and caespitose, floccose when young, becoming more glabrate in age, but with some wool always remaining: basal leaves, except the very first ones, from serrate or dentate to pinnatifid: stem leaves always present, but often reduced, generally pinnatifid or pinnately lobed or toothed: heads cymose, small, with few and very small calyculate bracts.

The group is closely related to the AUREI and LOBATI with which it is connected through *S. Plattensis* and *S. Fendleri* respectively. *S. Nelsonii* and *S. multilobus* in young state may also be sought here.

Basal leaves mostly dentate or crenate.

Basal leaves suborbicular, ovate or cordate; margins of the petioles arachnoid-tomentose. 25. *S. flavulus*.

Basal leaves obovate or spatulate.

Lower stem leaves acute; plant dark green. 26. *S. Plattensis*.

Lower stem leaves obtuse; plant yellowish-green. 27. *S. Neo-Mexicanus*.

Basal leaves lanceolate or oblanceolate.

Basal leaves narrowly oblanceolate, serrate. 28. *S. salicinus*.

Basal leaves lanceolate, sinuate-dentate. 29. *S. canovirens*.

Some of the basal leaves entire or dentate, the rest pinnatifid or pinnately lobed.

Plant conspicuously rosulate-stoloniferous; stem leaves sinuately round-lobed.

30. *S. rosulatus*.

Plant not stoloniferous; stem leaves pinnatifid with toothed lobes.

26. *S. Plattensis*.

All leaves pinnatifid with toothed segments.

Caudex subligneous; plant tomentose; bracts shorter than the disk.

31. *S. Fendleri*.

Caudex not subligneous; plant glabrate.

Bracts almost equaling the disk. 5. *S. Nelsonii*.

Bracts much shorter than the disk. 4. *S. multilobus*.

25. *SENECIO FLAVULUS* Greene, Pittonia, 4: 108. 1900

I have seen no specimens of this species, but from the description it must be most nearly related to the next, differing in the more slender habit, the small leaves and their form and the peculiar arachnoid tomentum on the margins of the petioles. The type was collected by C. F. Baker at Aboles, Colo., in 1899.

26. *SENECIO PLATTENSIS* Nutt. Trans. Am. Phil. Soc. II. 7: 413.

1841

This species is exceedingly variable as to the leaf form as well as to the pubescence; usually the basal leaves are merely serrate and obovate or oval in outline, but sometimes some of them are like the lower stem leaves, more or less lyrate pinnatifid. It is conspicuously floccose when young, but in age the leaves become almost glabrous and the wool remaining only on the lower part of the stem and petioles. The species belongs to the region of the plains. [Plate 6, f. 14.]

SOUTH DAKOTA : Brookings, 1897, *L. W. Carter*; Hot Springs, 1892, *P. A. Rydberg*, 828.

COLORADO : Fort Collins, 1895, *C. S. Crandall*.

INDIAN TERRITORY : Sapulpa, 1895, *B. F. Bush*, 1249; False Washita, 1868, *Edw. Palmer*, 461.

KANSAS : Riley Co., 1895, *J. B. Norton*, 303; Manhattan, 1887, *W. A. Kellerman*; Osborn Co., 1894, *C. L. Shear*, 28; Fort Riley, 1892, *E. E. Sayle*, 452.

NEBRASKA : Lincoln, 1887, *H. J. Webber*; Fort Niobrara, 1888, *T. E. Wilcox*; *Mrs. Austin*; Creete, *G. D. Swezey*.

MISSOURI : St. Louis, 1843, *Riehl*; McDonald Co., 1891, *B. F. Bush*.

ILLINOIS : Oquawka, 1873, *H. N. Patterson*.

27. *Senecio Neo-Mexicanus* A. Gray, Syn. Fl. 1²: 392. 1884

The original publication of this species is generally given as Proc. Amer. Acad. 19: 55, but no description is there to be found. As far as I can find, the one in the Synoptical Flora is the first published. Probably more than one species is included in that description and in the specimens cited below there are apparently three different types, but it has been impossible for me to find any constant characters by which to distinguish them. In one of them the stem leaves are more or less lyrate-pinnatifid and even the basal ones occasionally have a few lobes on the petiole, while in the others the stem leaves are narrow and merely toothed. The tomentum is sometimes deciduous, sometimes almost persistent. It grows at an altitude of 1200–2500 m. [Plate 6, fig. 7.]

NEW MEXICO : Silver City, Pinos Altos Mts., 1880, *E. L. Greene*; between Santa Fe and Canoncito, 1897, *A. A. & E. Gertrude Heller*, 3749; Organ Mts., 1895, *E. O. Wootton*; *P. V. LeRoy*.

ARIZONA : Fort Huachuca, 1892, *T. E. Wilcox*; 1876, *E. Palmer*, 614; Santa Catalina Mts, 1883, *C. G. Pringle*; San Francisco Mts., 1881, *H. H. Rusby*, 212; Mogollon Mts., 1887, *E. A. Mearns*, 58; Squaw Creek, 1887, *E. A. Mearns*, 171; Santa Rita Mts., 1881, *C. G. Pringle*.

28. *Senecio salicinus* sp. nov.

A floccose perennial, with a short cespitose caudex : stems several, about 4 dm. high, simple below, striate and floccose : basal

leaves 5-10 cm. long, narrowly oblanceolate, the first ones subentire, but most of them serrate except at the tapering base, finely tomentose on both sides, but in age more glabrate above: stem leaves small, linear, sessile, dentate, slightly auricled at the base: cyme compound: the heads subumbellate at the ends of the branches, 7-8 mm. high, slightly floccose at the base: bracts yellowish, thin, lanceolate, shorter than the disk: rays light yellow, short and broad, 3-4 mm. long and 2 mm. wide: achenes striate, glabrous.

A species related to *S. Fendleri*, but characterized by the narrow, merely serrate basal leaves, the small subumbellate heads in a short, flat-topped inflorescence with widely spreading ultimate branches. It grows in the foothills at an altitude of about 1800 m. [Plate 6, f. 6.]

COLORADO: J. Laramie Co., 1895, *J. H. Cowen* (type in the herbarium of N. Y. Botanical Garden).

29. *Senecio canovirens* sp. nov.

Stout perennial with a short erect rootstock, dark green, floccose with more or less deciduous wool: stem 4-5 dm. high, loosely floccose: basal leaves 5-12 cm. long, short-petioled; blades lanceolate or oblanceolate, sinuately toothed, dark green, firmly floccose, in age almost glabrate above: lower stem leaves similar; upper ones linear, sinuately dentate with rather acute teeth: cyme with erect or ascending branches: heads 7-8 mm. high, turbinate campanulate; bracts 12-14, oblong, linear, floccose at the base and more or less villose, acute, brownish on the back and with yellowish margins: rays 5-6 mm. long and 2 mm. wide, at first orange, in age paler, 4-nerved: achenes glabrous, striate.

The type was determined by Prof. Greene as *Senecio Fendleri*, but it is very unlike the typical form of the aggregate that has been known under that name. The dark green color, the leaves which are merely toothed, never pinnatifid and still less bipinnatifid as they often are in *S. Fendleri* easily distinguish it from that species. The perennial caudex and rootstock are similar to that of *S. Fendleri* but less thick and less woody and, as far as seen from the specimens, not branched. It grows at an altitude of about 2000 m. [Plate 6, f. 9.]

NEW MEXICO: White Mountains, 1897, *E. O. Wootton*, 244 (type in the herbarium of N. Y. Botanical Garden); Organ Mountains, 493.

COLORADO: Pike's Peak, 1895, *Mrs. S. L. Clarke*.

SENECIO MUTABILIS Greene, Pittonia, 4: 113. 1900

As I have seen no specimens of this species I have not been able to include it in my key. It may be the same as the preceding, but several characters given in the description do not agree with it, especially the deeply tridentate rays. Professor Greene is always criticizing other botanists for drawing vague descriptions. No better example of just such a description can be given than the one here made by himself.

30. *Senecio rosulatus* sp. nov.

Senecio aureus var. *Balsamitae* A. Gray, Proc. Acad. Nat. Sci. Phila. 1863: 68, in part.

More or less tomentose perennial, with a branched rootstock and generally numerous underground stolons producing leafy offsets: stems 2-3 dm. high, floccose or sometimes becoming almost glabrate in age; first leaves of the offsets spatulate and entire; other basal leaves and lower stem leaves oblanceolate, finely white tomentose especially on the lower surface, occasionally becoming more glabrate in age, sinuately pinnatifid with rounded lobes, petioled: upper stem leaves lanceolate or linear, sessile, auricled at the base also with rounded lobes: cyme corymbiform, open: heads small, 5-6 mm. high, floccose at the base: bracts about 12, broadly lanceolate, acute, yellowish with rather broad membranous margins, much shorter than the disk: rays about 5 mm. long and 2 mm. wide, 4-5-nerved: achenes strongly striate, glabrous.

The species has been confused with *S. Fendleri*, but is distinguished by the more slender rootstock and the numerous branches forming offsets, the entire first leaves not seen in that species and the short rounded entire lobes of the stem leaves. The heads are usually also smaller. It grows at an altitude of 2500-4000 m. [Plate 6, f. 4, 4a.]

COLORADO: Georgetown, 1885, *N. H. Patterson* 79 (type); Golden City, 1892, *E. L. Greene*; 1862, *Hall & Harbour*, 333, in part; 1871, *W. M. Canby*; Twin Lakes, 1873, *J. M. Coulter*; Pike's Peak, 1884, *G. W. Letterman*, 260; Caribou, 1891, *E. Penard*, 228; Fort Collins, 1896, *C. F. Baker*; Silver Plume, Gray's Peak, and Georgetown, 1895, *P. A. Rydberg*.

31. *SENECIO FENDLERI* Gray, Mem. Am. Acad. II, 4: 108. 1849

The typical *S. Fendleri* is a rather rare plant with a decidedly woody rootstock and caudex. None of the specimens seen show

any sign of entire leaves nor of subterranean stolons. The leaves are often bipinnatifid or pinnatifid with oblong toothed, and acutish segments. See also the remarks given under *S. Nelsonii*. [Plate 6, f. 3.]

NEW MEXICO : Santa Fe Cañon, 1897, *A. A. & E. Gertrude Heller*, 3774.

COLORADO : 1873, *Brandege*, 546.

UTAH : Salt Lake City, 1869, *S. Watson*.

Explanation of Plates

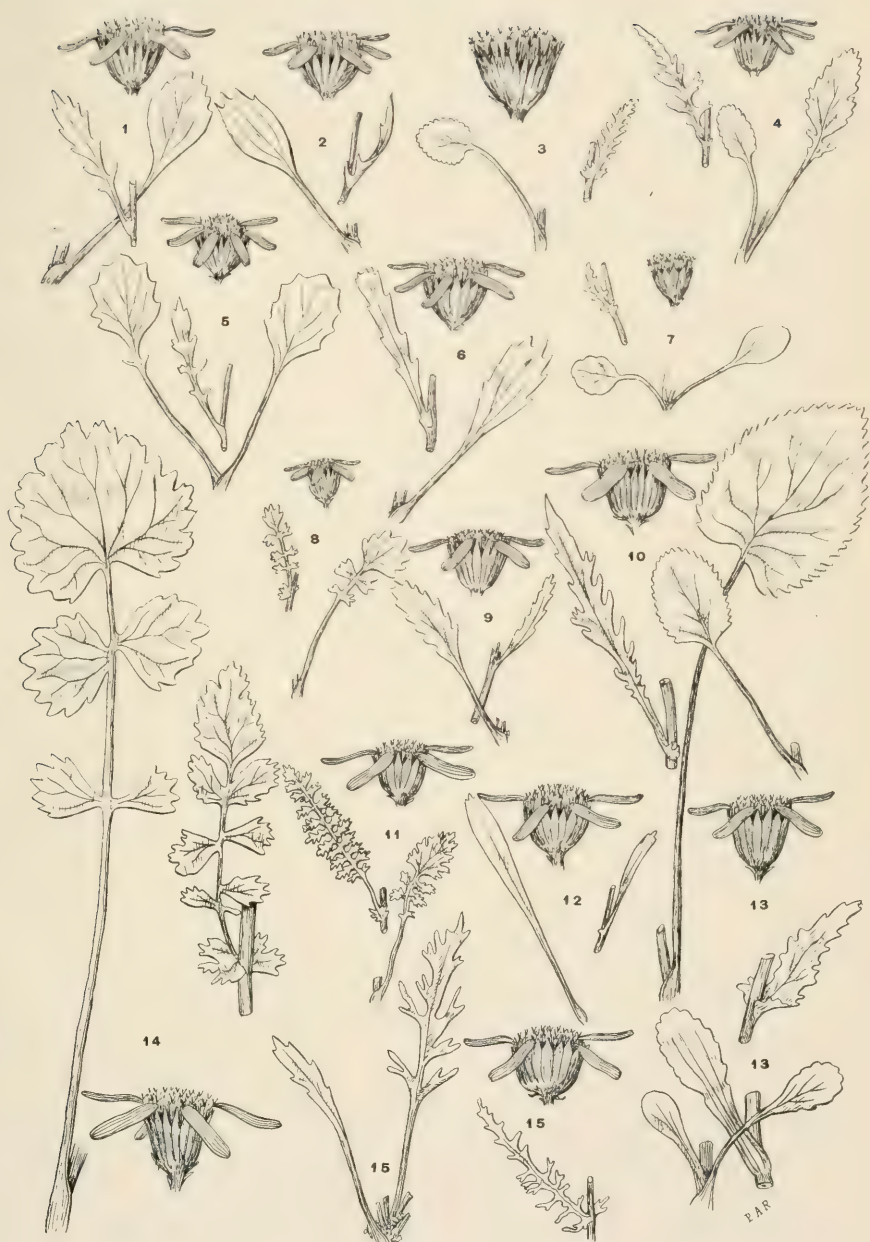
Unless otherwise stated, the drawings represent basal leaf, stem leaf selected a little above the middle of the stem and the head of each species. The leaves are reduced to one half and the heads are of natural size.

PLATE 5

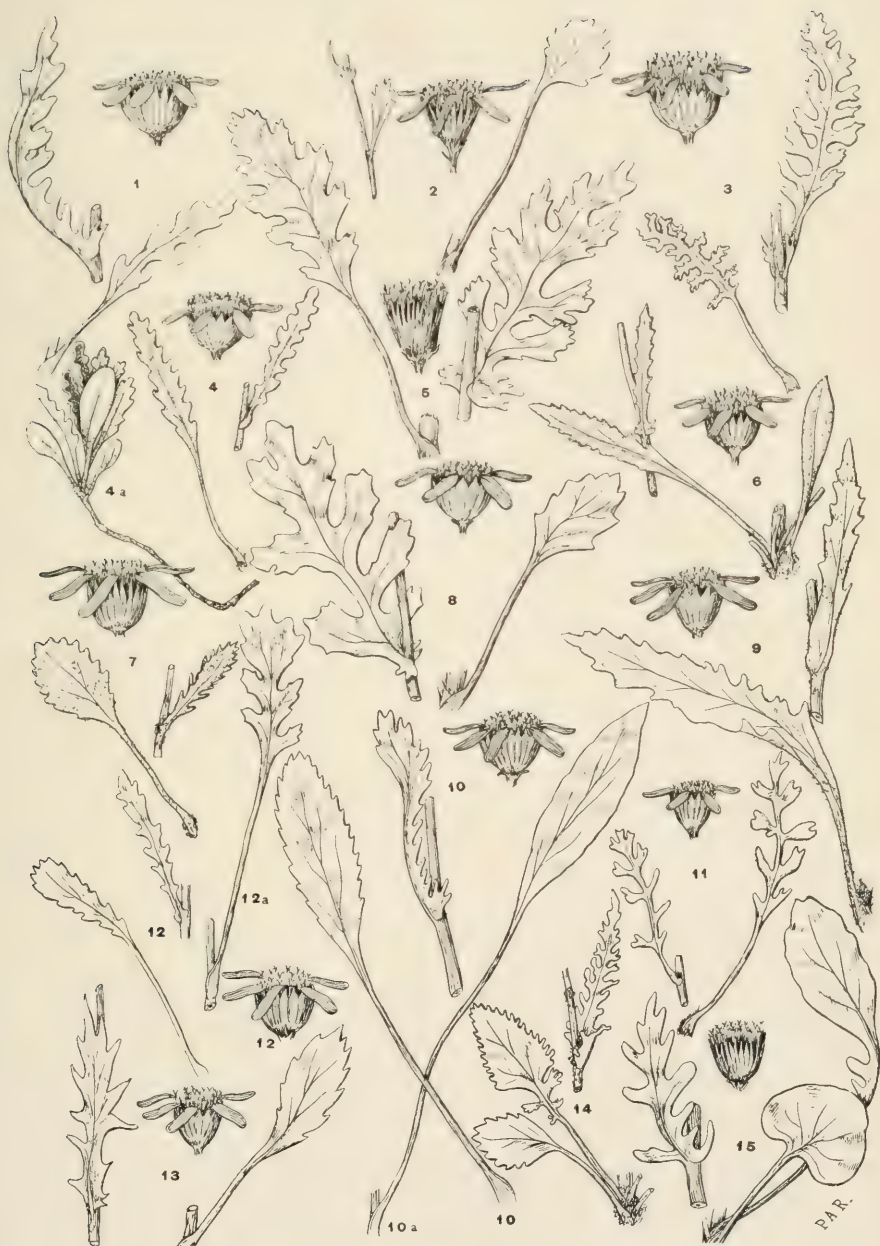
- | | |
|-----------------------------------|---|
| 1. <i>S. cymbalarioides</i> Nutt. | 9. <i>S. oblanceolatus</i> Rydb. |
| 2. <i>S. acutidens</i> Rydb. | 10. <i>S. pseud aureus</i> Rydb. |
| 3. <i>S. pauciflorus</i> Pursh. | 11. <i>S. millelobatus</i> Rydb. |
| 4. <i>S. flavovirens</i> Rydb. | 12. <i>S. tridenticulatus</i> Rydb. |
| 5. <i>S. Jonesii</i> Rydb. | 13. <i>S. crocatus</i> Rydb. |
| 6. <i>S. subcuneatus</i> Rydb. | 14. <i>S. sanguisoboides</i> Rydb. |
| 7. <i>S. fedifolius</i> Rydb. | 15. <i>S. compactus</i> (A. Gray) Rydb. |
| 8. <i>S. Greggii</i> Rydb. | |

PLATE 6

- | | |
|-------------------------------------|---|
| 1. <i>S. Nelsonii</i> Rydb. | 10. <i>S. longipetiolatus</i> Rydb. (from type). |
| 2. <i>S. subnudus</i> DC. | 10a. Basal leaf from <i>Baker, Earle & Tracy</i> , 625. |
| 3. <i>S. Fendleri</i> A. Gray. | 11. <i>S. multilobatus</i> Torr. & Gray. |
| 4. <i>S. rosulatus</i> Rydb. | 12. <i>S. aurellus</i> Rydb. |
| 4a. An offset of the same. | 12a. Lower stem leaf of the same. |
| 5. <i>S. Idahoensis</i> Rydb. | 13. <i>S. fulgens</i> Rydb. |
| 6. <i>S. salicinus</i> Rydb. | 14. <i>S. Plattensis</i> Nutt. |
| 7. <i>S. Neo-Mexicanus</i> A. Gray. | 15. <i>S. nephrophyllus</i> Rydb. |
| 8. <i>S. platylobus</i> Rydb. | |
| 9. <i>S. canovirens</i> Rydb. | |



RYDBERG ON SENECIO.



RYDBERG ON SENECIO.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 6

NOTES AND DESCRIPTIONS OF NORTH
AMERICAN PLANTS—I-II

BY JOHN K. SMALL

NEW YORK
1900

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and Vol. 27, No. 7, May, 1900.]

Notes and Descriptions of North American Plants.—I.

BY JOHN K. SMALL.

SAXIFRAGA NAPENSIS.

Perennial by very short rootstocks, scapose, almost glabrous or sparingly glandular-pilose above. Leaves basal; blades thinish (drying very thin), more or less obliquely oval or ovate, 2–7 cm. long, rounded at apex, undulate, abruptly or gradually narrowed at base, ciliate, sometimes slightly pilose on both surfaces: petioles slightly shorter than the blades or longer, broadly winged: scapes erect, slender, 1.5–3 dm. tall, loosely-paniculate-corymbose: calyx glabrous or glabrate; tube broadly turbinate, nearly 1 mm. high; segments oblong or ovate-oblong, slightly longer than the tube, obtuse or acutish, gland-tipped: corolla white, 5 mm. broad; petals broadly oval or suborbicular, 2 mm. long, rounded or notched at apex, sessile or nearly so, 5–7-nerved: ovaries united to calyx-tube, surrounded by a conspicuous lobed disk: follicles short and stout, 4 mm. high, united to each other to about the edge of disk: seeds dark red, 0.3 mm. long.

On hillsides, Napa Valley, California.

Collected by J. M. Bigelow (Whipple's Expedition) and George Thurber, no. 496.

A species of lax habit, resembling *Saxifraga claytoniaefolia* more closely than any other member of the subgenus *Micranthus*. It differs from *S. claytoniaefolia* by its broadly oval or suborbicular 5–7-nerved petals.

SAXIFRAGA VAN-BRUNTIAE.

Perennial, bright green, minutely glandular-pilose or glabrate below. Stems tufted, 2–7 cm. long, simple, or sometimes corymbosely branched above, leafy to the top: leaves alternate; blades linear, 4–8 mm. long, leathery, blunt, with a thick apex, sessile, turning black at the base of the plants: calyx glabrate in age; tube broadly turbinate; segments oblong or ovate-oblong, obtuse, longer than the tube, spreading: petals yellow, oblong, about 4 mm. long, obtuse, firm, more or less crisped, much longer than the calyx-segments: stamens 10, filaments filiform.

The original specimens of this hitherto undescribed *Saxifraga* were collected by Mr. and Mrs. Cornelius Van Brunt during the

past season on the summit of Sulphur Mountain near Banff, British Columbia. The species is related to *Saxifraga serpyllifolia* and *S. chrysantha*; the habit suggests those species but the stems are copiously leafy to the top and the leaves are narrower. The petals are smaller, of a much less brilliant yellow and oblong or ovate-oblong instead of oval-orbicular or obovate as they are in the two related species.

GALPINSIA TOUMEYI.

Perennial from a shrubby base, slender, bright green, puberulent. Stems branching near the base; branches erect or ascending, wire-like, 1-3 dm. long, usually simple above, leafy, pale when young; leaves numerous, sometimes clustered in axils; blades linear-spatulate to linear, 1-2 cm. long, acute, entire, with midrib prominent beneath, lower ones short-petioled, upper sessile; spikes few-flowered, leafy-bracted; calices very minutely pubescent; tube slender, 3-5 cm. long; segments about 1-5 cm. long, their free tips 5-6 mm. long; corolla yellow; petals orbicular-obovate, 1.5 cm. long, undulate; anthers linear, as long as the filaments; capsules linear-prismatic, 2 cm. long.

Arizona: Chincagua Mountains, July 25, 1894, J. W. Toumey, no. 197. Fort Huachuca, August, 1892, T. E. Wilcox.

The species just described is related to *Galpinsia Hartwegii*, but is of a much more slender build. There are minor characters in the foliage and habit, but one of the more crucial points of difference lies in the calyx, where we find the free tips of the segments 5-6 mm. in length.

LIMONIUM LIMBATUM.

Perennial, bluish green or glaucescent. Leaves basal; blades leathery, spatulate or oblong-spatulate, 0.5-1.5 dm. long, obtuse or notched at the apex, prominently nerved beneath in drying; petioles shorter than the blades or rarely longer, margined; scapes erect, solitary or several together, corymbosely branched; branches zigzag, ascending; spikes in dense terminal corymbs; bracts suborbicular or sometimes orbicular-oval, obtuse, often eroded at the apex, hyaline-margined; calyx trumpet-shaped with a flaring limb, nearly 4 mm. long; tube hirsute; segments broadly deltoid, apiculate; corollas bright blue.

In alkaline soil, Texas and New Mexico.

As far as I can learn there has been no attempt heretofore to

separate the Texan plant referred to *Limonium Californicum* either varietally or specifically. An examination of considerable material both from the Texas and the Californian districts discloses the fact that there have been two perfectly distinct species confused under the old *Limonium Californicum*. As in the case of all the species of the genus the two under consideration resemble each other in habit. The diagnostic characters are contrasted below :

Limonium Californicum. Calyx narrowly funnelform ; tube glabrous ; segments erect or nearly so, rounded and mucronulate.

Limonium limbatum. Calyx trumpet-shaped ; tube hirsute ; segments more or less spreading, broadly deltoid.

The following specimens belong here : Wright, no. 1435 ; Woodhouse, Zuni Mts., N. M., Aug., 1851 ; Wooton, no. 172.

ANDROSACE DIFFUSA.

Annual, acaulescent, more or less pubescent. Leaves basal ; blades oblanceolate to spatulate or nearly linear, 1-4 cm. long, obtuse or acute, sharply serrate above the middle or sparingly toothed near apex only, sessile or with short winged petioles : scapes erect and spreading, often diffusely branched at base, 5-10 cm. long or shorter : bracts lanceolate : pedicels filiform, very variable in length, often 1-8 cm. long in the same cluster : calyx campanulate to turbinate-campanulate, 3-3.5 mm. high ; segments triangular, acute, ciliate, about $\frac{1}{2}$ as long as the 5-ridged tube ; corolla white or pink, included, sometimes equalling the tips of the calyx-segments, 3-3.5 mm. broad ; segments oblong, obtuse or retuse at apex, about as long as the tube : filaments shorter than the anthers : capsules subglobose, about 3 mm. in diameter.

In rocky soil, western Arctic America to the Dakotas, New Mexico and Arizona. Spring and summer.

For some inexplicable reason the species here described as new has always been associated with *Androsace septentrionalis* with which it has not even a habital resemblance. *Androsace septentrionalis* is a plant with strict, conspicuously elongated scapes which are surmounted by umbel-like clusters of pedicels of nearly equal length, whereas *Androsace diffusa*, has comparatively short, more or less diffusely spreading scapes, while the pedicels of the clusters are exceedingly variable in length. A more tangible

character exists in the corolla. In *Androsace septentrionalis* this organ conspicuously surpasses its calyx while in the newly described species it is shorter than its calyx or barely equals it.

ANDROSACE SUBUMBELLATA (A. Nelson).

Androsace septentrionalis subumbellata A. Nelson, Bull. Wyom. Exp. St. 28 : 149. 1896.

Annual, diminutive, sparingly pubescent. Leaves basal ; blades thick, oblong, 2-8 mm. long, obtuse, entire, sessile : scapes 1-5 mm. long, or wanting : bracts ovate-lanceolate or lanceolate, pedicels solitary or several together, 5-10 mm. long : calyx nearly glabrous, turbinate-campanulate, 2.5 mm. high ; segments triangular, acute, slightly shorter than the 5-ridged tube : corolla white or pink, 2.5-3 mm. broad, surpassing the calyx ; segments oblong, obtuse, or retuse at the apex, shorter than the tube ; filaments much shorter than the anthers : capsule globose-pyriform, about 2 mm. thick.

On hillsides, near summit of Union Peak, Wyoming. Summer.

In order to treat this genus consistently, we should recognize the above as a species. On the one hand *Androsace subumbellata* is related to *Androsace diffusa* : this species it resembles in habit and foliage, but it is more diminutive in all its parts. On the other hand it is related to *Androsace septentrionalis* in having the corolla exerted beyond the calyx.

PRIMULA SERRA.

Perennial, glabrous or nearly so, deep green. Leaves basal, 5-10 cm. long ; blades narrowly oblong or spatulate, much longer than the broadly winged petioles, rather regularly dentate, acute or apiculate : scapes erect, 1-2 dm. tall, solitary or several together : bracts scarious, ovate-lanceolate, acuminate, often minutely pubescent : pedicels 1-3 cm. long, glabrous in age : calices 6-7 mm. long ; tube campanulate ; segments lanceolate, granular-ciliate, acuminate, as long as the tube or shorter : corollas lilac-purple ; tube as long as the calices or somewhat longer ; segments suborbicular or obovate-orbicular, notched at apex, 7-8 mm. long, destitute of apiculations.

Primula serra resembles *Primula Rusbyi* in habit, but both the foliage and the inflorescence furnish characters for distinguishing the two species. In the case of the species just described we find

more coarsely toothed leaf-blades and shorter petioles ; but more prominent characters exist in the inflorescence : The calices are twice as large as those of *Primula Rusbyi*, the corolla-tubes are comparatively stout and they never twice exceed the length of the calices as do the very slender tubes of *Primula Rusbyi*. In addition, the lobes of the corolla-segments are destitute of the minute but characteristic apiculations found in the related species.

The original specimens were collected by Mr. Pringle on damp ledges, Santa Rita Mountains, Arizona, at an altitude of 8000 feet, on July 25, 1884.

PRIMULA TENUIS.

Perennial, glabrous, bright green. Leaves basal, 0.5-1.5 cm. long ; blades oblong, oval or suborbicular, undulate or toothed, obtuse or acutish, much shorter than the slender petioles : scapes erect, wire-like, 5-10 cm. tall, solitary : bracts linear-subulate, 1-5 mm. long : calices 3-5 mm. high, tubes turbinate, segments narrowly lanceolate to narrowly linear, longer than the tube, acute : corollas pink, 4-5 mm. broad ; tubes surpassing the calices, 4 mm long, notched at the apex.

In moist places, Pastolic, Alaska.

A delicate species related to *Primula borealis*, but much more slender ; easily distinguished by its flimsy leaves, shorter pedicels turbinate calyx-tubes and narrow calyx-segments. The corolla tube is further exserted than in *Primula borealis* and the more delicate lobes less deeply notched.

The original specimens were collected by W. H. Dall, on June 25, 1871, or 1872.

Notes and Descriptions of North American Plants.—II

BY JOHN K. SMALL

I. NOTEWORTHY SPECIES

HABENARIA GARBERI Porter, Bot. Gaz. **5**: 135. 1880

The original and second known stations for this interesting orchid are both near Manatee, Florida. A second locality can now be placed on record; this is Orange County, Florida, where Mr. F. L. Lewton discovered the species at several stations in the summer of 1894. His specimens are essentially the same as the type.

HABENARIA MACROCERATITIS Willd. Sp. Pl. **4**: 44. 1805

This remarkable tropical *Habenaria* has been found native in Florida, by Mr. Lewton. It is not rare in Sumter County, where he first met with it in 1894.

THERMOPSIS MOLLIS (Michx.) M. A. Curtis, Mem. Am. Acad. II.
3: 47. *pl.* 9. 1848

Heretofore this comparatively rare species has been reported as growing in the mountains of Virginia and North Carolina. But its range is wider than this; in May, 1869, Mr. Canby collected it on Lookout Mountain, Tennessee, and on May 21, 1890, Professor Scribner rediscovered it at the same locality.

PLUCHEA IMBRICATA (Kearney) Nash, Bull. Torr. Club, **23**: 108.
1896

Excellent specimens of this *Pluchea* were collected in swamps about Forest City, Orange County, Florida, by Mr. F. L. Lewton in July, 1893. The specimens of this collection agree almost perfectly with the type.

HIERACIUM SCRIBNERI Small, Bull. Torr. Club, **21**: 20. 1894

Professor Ruth has sent me almost typical specimens of this rare member of *Hieracium* from near Knoxville, Tennessee, where he collected the plant in 1897.

SENECIO MILLIFOLIUM T. & G. Fl. N. A. 2: 444. 1843

In 1887 Mr. E. R. Memminger rediscovered this rare *Senecio* in Henderson County, North Carolina, where it was collected many years ago by Buckley. In 1895 Mr. A. M. Huger sent me specimens from Macon and Jackson counties, North Carolina, where he found it growing plentifully on sloping cliffs at altitudes ranging from 1100–1400 meters.

II. HITHERTO UNDESCRIBED SPECIES

Allium arenicola

Bulbs nearly 1 cm. long, with fibrous outer coats. Leaves basal; blades very narrowly linear, becoming almost filiform, about as long as the scape or shorter: scapes erect, sometimes several together, 1–3 dm. tall, more or less curved: umbels erect, 10–30-flowered: pedicels 5–10 mm. long, slender: perianth deep pink; segments linear to narrowly linear-lanceolate, about 4 mm. long, very delicate: filaments dilated below: capsules not crested.

In sandy soil, Mississippi. Spring.

This species has been confused with *Allium mutabile* Michx. for nearly three quarters of a century. It is much more slender in habit and smaller in all its parts. The type specimens were collected by Martha B. Flint at Brookhaven, Mississippi, April 1, 1888.

Ranunculus cuneiformis

Foliage hirsute below the inflorescence. Roots thickened, clustered: stems usually several together, 2–3 dm. tall, erect or ascending, rather slender: leaves mainly basal; blades, at least some of them, twice-divided into cuneate rather obtuse segments, 5–10 cm. long, about as long as the petioles; upper stem leaves with blades 3-parted; segments narrow, often incised: flowers yellow, about 1.5 cm. broad, on strigillose peduncles: heads of fruit subglobose or ovoid-globose, about 1 cm. long: receptacle barely elongated: achenes 4 mm. long, conspicuously winged and with a triangular beak.

On prairies, near Kerrville, Texas. Spring. Heller, Pl. S. Tex. no. 1688. It differs from its relative as shown below:

RANUNCULUS CUNEIFORMIS

Blades of lower leaves twice-divided : corollas 1.5 cm. broad : heads of achenes subglobose or ovoid-globose, receptacle barely elongated : achenes conspicuously winged, with triangular beaks.

RANUNCULUS MACRANTHUS

Blades of lower leaves once-divided : corollas 3-5 cm. broad : heads of achenes oblong to cylindric : receptacle elongated : achenes narrowly margined, with subulate slightly curved beaks.

Ranunculus Mississippensis

Perennial, stoloniferous, fleshy. Stems stout, about 2 dm. tall, more or less branched : leaves various ; basal or those on the lower part of the stem with ovate or ovate-lanceolate sinuate-dentate blades 1.5-4 cm. long, and elongated petioles, upper leaves with oblong or linear remotely-toothed blades 3-8 cm. long : flowers few : sepals oblong to suborbicular, sparingly pubescent : corollas about 1.5 cm. broad ; petals about 9, nearly oblong, deep yellow and lustrous within.

In low grounds, Arkansas and Mississippi. Spring.

ARKANSAS : Varner, Lincoln Co., April 28, 1898 ; *Bush*, no. 12.

MISSISSIPPI : "Alluvions." 1840 ; *Peck*.

Related to *Ranunculus oblongifolius*, but more robust, with truncate or cordate blades terminating the elongated petioles of the lower or basal leaves and much larger corollas consisting of about nine petals.

Thalictrum mirabile

Perennial, slender, glabrous, bright green. Stems erect, 1-3 dm. tall, wiry, dichotomously branched above : leaves various, basal usually ternately compound, with petioles about 2 cm. long ; upper leaves gradually more simple and shorter petioled : leaflets suborbicular or orbicular-reniform, 2-3 cm. broad, very thin, delicately nerved, glaucescent beneath, broadly crenate or shallowly crenate-lobed, truncate or subcordate at the base, longer than the petiolules : peduncles hair-like : flowers white : sepals spatulate or rhombic-spatulate, fully 1.5 mm. long : filaments fully 2 mm. long, club-shaped by an abrupt thickening about the middle : fruit spreading at right-angles to the peduncle ; body plump, about 2 mm. long, acute, not depressed along the upper side, as long as the filiform stalk or shorter.

Resembles *Thalictrum clavatum* but more delicate and smaller throughout, and with very short-petioled basal leaves. The fruit

is only about one-half the size of that of *T. clavatum* and has a plump barely ribbed body not at all depressed along the upper side.

The original specimens were collected by Prof. F. S. Earle under sandstone bluffs on Little Mountain near Moulton, Alabama, June 25, 1899, no. 2212.

Phyllanthus Avicularia

Perennial, bright green. Stems branched at the base and throughout, 3–6 dm. long, puberulent, striate in age: leaves numerous, ascending: blades oblong, or slightly broadest above the middle, 8–18 mm. long, blunt or barely pointed, slightly paler beneath than above, rounded or truncate at the base: petioles 1 mm. long, or shorter: calices short-pedicelled; staminate delicate, barely 2 mm. broad, sepals orbicular-obovate or suborbicular: pistillate firmer, fully 2 mm. broad or barely 3 mm. broad at maturity; sepals oblong or oval, scarious-margined, persistent: capsules spheroidal, 3 mm. broad.

In dry soil, along the Brazos River, Texas. Type from Columbia, Texas, collected by B. F. Bush, October 26, 1899, no. 263.

Related to *Phyllanthus polygonoides*, but much more robust in all its parts. The leaves, too, are of an oblong type. The capsules conspicuously surpass the mature pistillate calyx, whereas those of *P. polygonoides* are at least equaled by the mature sepals.

Oenothera nyctaginiifolia

Apparently annual or biennial, sparingly pubescent. Stems branched at the base, branches spreading or decumbent, 2–5 dm. long, more or less branched: leaves rather few; blades lanceolate to ovate-lanceolate, 2–5.5 cm. long, acute or slightly acuminate, often somewhat crisped and twisted, undulate, ciliate, cuneate or truncate at the base; petioles 2–6 mm. long, pale, margined: flowers axillary: hypanthium bristly and with very slender hairs, especially about the ovary; tubular portion about as long as the ovary: sepals linear-lanceolate, fully 1.5 cm. long, thin and delicate: capsules 4–5 cm. long, club-shaped by the sterile basal portion which is slightly shorter than the fertile portion, about 4 mm. thick: seeds 1.5 mm. long, reticulated.

In dry soil, Flagstaff, Arizona, September 5, 1894, *J. W. Toumey*.

More closely related to *Oenothera laciniata* than any other species. It differs in the larger flowers and the club-shaped capsules, besides the conspicuous character of the leaves. These members are very suggestive of the leaves of *Nyctaginia* or the broad-leaved species of *Allionia*.

Phlox Brittonii

Perennial, deep green. Stems copiously branched; branched matted, forming wide tufts, glandular-pilose; leaves numerous, small ones often clustered in the axils of the larger; blades subulate or narrowly linear-subulate, 5–10 mm. long, ciliate, especially near the base; calices 5–6 mm. long, glandular-pubescent like the branches; segments subulate, about as long as the tube; corolla white; tube curved, about 1 cm. long; limb 12–13 mm. wide; segments cuneate, with 2 pale magenta spots near the base, cleft by a V-shaped sinus about 3 mm. deep, usually with a minute tooth in each sinus, tips acute or acutish.

On dry mountain slopes, Virginia and West Virginia to North Carolina. Spring and Summer.

A relative of *Phlox subulata* but more delicate in all its parts. The contrasting characters may be shown as follows:

PHLOX BRITTONII

Stems or branches glandular-pilose; leaf blades mostly 5–10 mm. long; calices 5–6 mm. long; limb of corolla less than 14 mm. broad; lobes usually with a minute tooth in each sinus.

PHLOX SUBULATA

Stems or branches not glandular; leaf-blades mostly 10–15 mm. long; calices 8–9 mm. long; limb of corolla over 15 mm. broad; lobes usually with toothless sinuses.

The specimens upon which the species is based were collected by Dr. N. L. Britton, at White Sulphur Springs, West Virginia, May, 1898. Dr. Britton then introduced the species in the herbaceous grounds of the New York Botanical Garden where the plants have become thoroughly established.

Vernonia interior

Perennial, finely and usually closely pubescent. Stems erect or ascending, 1–2 meters tall, simple below the inflorescence; leaves numerous; blades elliptic to elliptic-lanceolate, 6–20 cm. long, acuminate, sharply and rather finely serrate, sessile or nearly so; heads numerous, rather crowded; involucre campanulate, 6–7 mm. high, 4–5 mm. broad; bracts pubescent, sometimes hoary, acute or with short keel-like acuminations, the tips erect or slightly spreading; achenes pubescent; pappus purple.

On plains or prairies, Missouri and Kansas south to Texas. Spring to fall.

The species just described has heretofore been confused with *Vernonia Baldwinii* and *V. Drummondii*. It is readily separable from its nearest relative, *Vernonia Baldwinii* by the smaller involucre and their bracts which have erect or barely spreading tips. The following cited specimens belong here:

MISSOURI: Jackson County, *Bush*, no. 233A; McDonald County, *Bush*, no. 232.

NEBRASKA: Lincoln, *Webber*, September, 1888.

TEXAS: Kerrville, *Heller*, Pl. S. Tex. no. 1927.

This species has been raised from seed in the nurseries of the New York Botanical Garden and is now established in the herbaceous grounds.

Vernonia maxima

Foliage glabrous or sparingly pubescent. Stems erect, 1-3 meters tall, branching above: leaves rather numerous: blades narrowly elliptic to lanceolate or linear-lanceolate, 1-3 dm. long, acuminate, sharply serrate, narrowed into short petioles or the upper ones nearly sessile: corymbs 1-4 dm. broad: peduncles angled, barely enlarged upward: involucre hemispheric, 4 mm. to nearly 5 mm. high, rounded at the base: bracts ovate to oblong, acute to mucronate, ciliate, appressed: achenes 3 mm. long, upwardly barbed on the ribs: pappus light or deep purple.

In low ground, Ohio to Missouri, south to Alabama and Louisiana. Summer and fall.

For many years *Vernonia gigantea* or *V. altissima* has been an aggregate. The campestrian plant that has been known under both of those names is very distinct from the Carolinian and Floridian plant to which both the above cited names were originally applied.

The campestrian plant may easily be separated from the southeastern species by the lower involucre with rounded bases and their proportionately broader appressed and compactly arranged bracts. The involucre of the related species are narrowed at the base and have narrower loosely spreading bracts. The following cited specimens belong here:

MISSOURI: Jackson County, *Bush*, no. 230.

OHIO: no locality, *Riddell*, 1834. Scioto, *Merriam*, September 28, 1891.

WEST VIRGINIA: Monongalia County, *Millsbaugh*, no. 677.

KENTUCKY: no locality, *Short*, 1842. Harlan County, *Kearney*, no. 188.

TENNESSEE : Knoxville, *Ruth*, September, 1894.

MISSISSIPPI : Agricultural College, *Pollard*, no. 1267.

Lacinaria Halei

Perennial, glabrous or nearly so. Stems erect, 6-9 dm. tall, simple or sparingly branched : leaves various ; lower with linear blades 1-2 dm. long, upper narrowly linear and much shorter, not ciliate near the base : heads short-peduncled or nearly sessile, not densely crowded : involucre becoming narrowly turbinate, 7-9 mm. high : bracts lanceolate to oblong-lanceolate, acuminate, ciliate, rigid : pappus plumose : achenes closely pubescent.

On prairies, Louisiana. Summer.

This species has heretofore been included in *Lacinaria acidota*, with which it has little or nothing in common, and it may be separated by its fewer leaves and much smaller heads which are disposed in elongated interrupted spikes. The bracts of the involucre are much shorter than those of *L. acidota* and have less elongated tips.

The species is founded on Hale's no. 334.

Lacinaria platylepis

Perennial, bright green. Stems erect, 8-9 dm. tall, simple, glabrate below, pubescent with white hairs above : leaves not very numerous, narrowly linear, 2-10 cm. long, or longer at the base of the stem, glabrous or nearly so : heads rather approximate, sessile, surpassing the subtending bracts : involucre cylindric-campanulate, 7-9 mm. long ; outer bracts often ovate, acute, inner larger and broader, broadest above the middle, rounded at the apex, ciliate : pappus not plumose, pale.

In sandy soil, Louisiana.

Plants belonging here have been referred to *Lacinaria acidota*, although none of the several characters warrant such a disposition. The fewer and shorter leaves, the elongated more or less interrupted spikes and smaller heads and involucre with their broad rounded inner bracts, are some of the characters that separate *Lacinaria platylepis* from *L. acidota*. The pappus too is not plumose.

The original specimens were collected in Louisiana by Dr. Hale.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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VEGETATIVE REPRODUCTION AND MULTI-
PLICATION IN ERYTHRONIUM.

BY FREDERICK H. BLODGETT

NEW YORK
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Vegetative Reproduction and Multiplication in *Erythronium* *

BY FREDERICK H. BLODGETT

(WITH PLATES 16-18)

John Burroughs, in Riverby, speaking of the yellow *Erythronium* as he found it in grass-covered meadows, calls attention to the brittle white threads which often appear above the turf. These he found were connected with the immature bulbs, from which they penetrate the soil in various directions.

The nature and purpose of these threads were studied in 1893 and 1894.† They are smooth, scaleless offshoots or subterranean runners, heavily charged with starch. The tip encloses a bud which will become a bulb upon the death of the parent bulb. In this species, and in *E. albidum* the runners arise from the base of the parent bulb, differing in this respect from *E. propullans* Gray, which produces the offshoots from the side of the stem above the bulb.‡

The bulbs formed at the distant end of the runners repeat the process indefinitely, producing annual crops of runners and runner-bulbs until the conditions are met which result in flowering plants. When the necessary vigor, depth and size are reached which cause the development of a flower bud in addition to the leaf bud within the bulb, the annual runners cease to be produced; but when the flowering bulb is removed from those conditions, runners are again produced. The runners are first produced from the bulbs which are formed during the growth of the seedling; the last crop gives rise to flowering bulbs four years or more after the seed has ripened. After the runners cease to be produced, annual bulbs are formed within the mature bulb, resembling the runners in their structure save that there is no lengthening between the terminal bud and the point of origin.

* Read in abstract before the Society for Plant Morphology and Physiology, New Haven, Dec. 27, 1899.

† Bot. Gaz. 19: 61. 1894; and 20: 172. 1895; with illustrations.

‡ Am. Nat., July, 1871. A new Species of *Erythronium*. Dr. Gray mentions also the function of the offshoots in the species *Dens-canis*, *Americanum* and *propullans*.

The mature bulbs are usually in good flower about the middle of April, and the seeds ripen in June. They must be looked for among the leaves upon the surface of the ground, as the entire plant becomes withered and prostrate soon after the fall of the flowers. The ripe seeds are about 6 mm. long, half as wide, and in shape resemble, distantly, a segment of an orange, on account of a prominent raphe and spur along one side (Fig. 1). In texture the seed is firm and hard; in color, brown darkening with age and exposure. The surface is strongly convex, and smooth, though hardly shining. The raphe and spur are absent in seeds which have lain in the soil over winter. In *Erythronium Dens-canis* the raphe is less developed, the spur is present as a slender curved hook or beak from the apex of the seed.*

The seeds remain dormant for nine months—from June to April, when they germinate (Fig. 4), reaching their best development as seedlings (Fig. 7), about the time that the flowers are in their prime. The young plant elongates in opposite directions: the upper end, the tip of the cotyledon, contains a gland (Fig. 6, *g*) by which the food substance of the seed is absorbed. The lower end is protected by a root cap during the first stage of its growth. While the tip of the cotyledon advances the length of the seed, the opposite end penetrates the soil for an inch or more. About the time that the food is absorbed from the seed and the cotyledon frees itself from the empty testa, the descending part changes also. From one side of this portion, close to the tip (*r*, Fig. 5), the radicle is produced, and penetrates farther into the soil. It is plentifully supplied at its base with root hairs (Fig. 9).

The cotyledon is supplied, for the greater portion of its length, with stomata, and functionally it is a cylindrical leaf. Starch is scattered through it, being in all portions of the tissue at *a* (Fig. 23), mostly epidermal in the guard cells of the stomata at *b*, usually near the fibrovascular bundles at *c*, and general again at *d*. Close to the tip (*d*) there is a local deposit of starch, as if provided for the growing cells just within the root cap (*S*, Fig. 5). The part from which the radicle springs enlarges, becomes charged with starch, and forms a bulb (Fig. 9), which is usually forced

* Irmisch: Beiträge zur verg. Morphologie der Pflanzen. Abhand. d. Natur. Gesell. zu Halle, 17³: 184-195. 1863.

deeper into the soil at the end of a short vertical runner, but may develop without such elongation. Within this bulb the plumule is formed (Figs. 10, 11) and with its formation the first step in the vegetative life of the plant is completed. The second step appears the next spring with the first leaf—the plumule leaf, and ends when the first crop of runner bulbs is formed in May.* From the plumule-bulb only one or two runners are generally produced, but from the larger bulbs three is the more common number (Fig. 12), thus increasing three-fold the number of immature bulbs at each successive crop of runners.

A flowering bulb cannot be produced from seed in less than four years. In the first year the parent bulb would bloom, and ripen its crop of seeds, from six or seven to twenty or more. In the spring of the second year some of these seeds would germinate and form plumule-bulbs. From each of the plumule-bulbs there would appear in the third year a single leaf, and the first runners would be produced at the distant ends of which runner-bulbs would be formed. Some one of these runner-bulbs might be formed under the conditions necessary to produce a flowering bulb, but this is very unlikely; so that one or more years would elapse before a blossom would be formed, thus making a cycle of five or more years. This cycle is shown at Fig. 14, with the forms assumed at each step. At Fig. 26 the multiplication which takes place during the same cycle is shown diagrammatically: one seed; one seedling and plumule-bulb; one runner bulb; three runners with their bulbs; and from each of these three there are produced three more the fifth year, nine in all. Some of the nine will probably produce a flower; those which do not will continue to produce runners in most cases, although a bulb is occasionally found which is apparently recuperating, for the depth is that of the mature bulbs, but only one leaf is produced, and no runners are present.

The following table illustrates the number of plants of different ages during each of five years, supposing that five seeds from each fruit ripen and survive the cycle. Each step is one line lower

* No bulbs of plumule size were found this spring (1900) with runners. The stiff clay soil in which most of them were found may have some influence upon the absence of runners.

than the next preceding one, thus the five "seeds" of 1899, become "5 plumule-bulbs" in 1900, giving a total of 75 plants in 1903.

1899	1900	1901	1902	1903
5 seeds	5 seeds	5 seeds	5 seeds	5 seeds
	5 plumule-bulbs	5 plumule-bulbs	5 plumule-bulbs	5 plumule-bulbs
		5 yearlings	5 yearlings	5 yearlings
			15 2 years old	15 2 years old
				45 flowers
				Total 75 plants

There is very little chance that there will be forty-five blossoms at the end of five years, but as some of the bulbs will probably flower then it is convenient to call the entire number by one name, when they are of the same crop or age.

The seed resembles that of *Iris* in structure.* The walls of the cells are thickened; at certain points the walls of adjacent cells retain their normal thin nature, so that a thin membrane only separates the cell cavities. The cells are arranged with their longer axes nearly perpendicular to the surface of the seed, and in this way form lines which extend to the central portion of the endosperm. Through the center of the seed a mass of dense reserve cellulose extends (Fig. 19) with a few cell cavities scattered through it. In the apex of the seed, and at the beginning of this mass of dense material lies the embryo (Fig. 20). At germination the embryo elongates, pushing the tip of the cotyledon along the center of the seed, absorbing the dense cellulose as it advances. From the cavity thus formed in the center, the solvent action extends toward the surface of the seed, following the lines of the cells, and producing a honey-comb effect (Fig. 8). This honey-combing is the more easily produced on account of the cell arrangement which in a longitudinal section appears as in Fig. 18, *a*; in a horizontal one, as at *b*. The thin wall separating the depressions in the thickened walls of adjacent cells readily dissolves under the action of the absorbing gland of the cotyledon, thus opening a passage for the movement of food materials from cell to cell, as the solvent action extends. The dissolved material moves along the channels so made toward the tip of the cotyledon. The absorbing organ (Fig. 6, *g*) is quite similar in structure, and probably

* Haberlandt, Pflanzen Anatomie, 298.

in action also, to the glands in the hairs of *Drosera*.* One or two layers of cells cover the end of the fibro-vascular bundle which is slightly larger than in the body of the cotyledon. No starch is present in the seed, except in the raphe and spur, where a few grains are scattered through the thin-walled cells (Fig. 18, c). During the growth of the seedling starch is found just within the glandular tip of the cotyledon, and in other portions as already stated.

When the food material has been exhausted the cotyledon "elbows" its way to the surface and functions as a leaf. At this stage it resembles an onion seedling, but unlike the onion no further development of foliage occurs until a year later. The plumule-bulb is now forming and is complete, as a bulb, about the time the seedlings wither early in May. The plumule is formed at the base of the swelling at the origin of the radicle (*p*, Fig. 10). At first a mere line of division separates the plumule cells from the other cells of the young bulb. Later the plumule appears as a protuberance at the bottom of a small cavity in the base of the bulb (*p*, Fig. 11). After the cotyledon withers the plumule continues to develop, until a small leaf is formed by the first of November. The plumule-bulb becomes heavily charged with starch early in its development, and thereafter the subterranean portions, except the shoots inside the bulbs are starch bearing.

Runners have their origin at the base of the stem, as a bud in the axil of the inner bulb-scale. From this point (Figs. 13, 15) they push out irregular distances, and at the completion of their growth form bulbs from their terminal buds. Mature bulbs are annually renewed from similar buds (Fig. 17), which develop inside of the parent, beginning as buds in December; the new bulb being full size just after the blossoms fall, in late April. Fig. 30 shows the new bulb at the time that the parent is in prime flower.

The runner and annual bulbs begin to form the buds for the next spring's leaves and flowers, in May. The first evidence is a discolored line or streak extending upward from close to the bottom of the bulb; soon there appears a cavity at the lower end of this streak, in which a short sprout is visible in June or July (Fig. 16). This sprout continues to develop until in November and

* Kerner, Nat. Hist. of Plants, 2: 145. *f.* 126.

December the floral parts are all present and well developed including the ovules and the pollen mother-cells, and the perianth is often tinged with yellow. As the spring advances the bulbs push their sprouts further and further toward the surface, and when the frost is fairly out of the ground the short distance remaining is quickly passed, and the flowers open while there may still be snow on shaded hillsides. The sprout penetrates the soil in the manner of an awl, piercing leaves and decayed wood which may lie in its path,* rather than growing around, or lifting them. For this awl-like work the sprout is protected by a hard tip, which forms the apex of the leaf when the latter expands.

In Fig. 22 the successive steps are shown, by which the flower becomes freed from the enclosing leaves, and assumes its nodding position on the pedicel. At the left (*a*) the sprout has fully penetrated the soil and the leaves have begun to relax their tight clasp upon the bud. The outer and larger leaf expands gradually, while the inner one remains close to the bud as shown at *b*. Next the two leaves bend downward toward their final position, the bud still held by the margins of the inner leaf, *c*. When the leaves have reached nearly their normal position, the bud is released *d*, and it then stands erect between the leaves, as at *e*. In a short time the stem begins to bend near the bud, as at *f*, and as the bud begins to open it has assumed the position shown at *g*.

The last two positions alternate while the plant remains in flower, position *f* being assumed on bright days, when the open flower, with strongly recurved petals, is turned upward, returning to the nodding position at night and on less warm or less sunny days. With the fall of the flower the enlarging fruit assumes an erect position upon the stem, which is retained until the whole plant is withered and lies prostrate on the ground; the ripe seeds remain quite close to the open capsule.

Erythronium Americanum in its mature development normally bears two unequal leaves and a single flower. During the past two or three seasons a number of unusual cases have been observed, in one of which two flowers were borne on an otherwise normal plant. More frequently one leaf only was present in a plant otherwise normal. Over a dozen plants showing the latter

* Bessey, C. E., A vegetable Awl, Plant World, 1: 132.

form of variation were found in an hours' collection in New Jersey. A plant collected at Washington, D. C., had one leaf (Fig. 28) eight stamens and seven petals; the flower is shown at Fig. 27. Plants having three leaves, with one flower; and four leaves, with two flowers; have been found at long intervals. Fig. 31 shows also three rosettes formed by the root fibers, which indicates the minimum age of the bulb at the depth at which it was found, that is, three years.

Bulbs and runners also have unusual developments, such as surface buds or stimulation growths. The latter seems to have started after a rain or other stimulation, and bursting through the partly formed runner bulb, has grown further into the soil. Fig. 31 shows one in which the nearly formed bulb is burst in two directions, sending a continuation downward, and attempting to produce leaves through the upper opening. These rudimentary leaves showed a trace of yellowish green when first gathered. In bulbs which have been injured, so that the sprout from the center of the bulb fails to develop, a surface bud may be formed. Two such bulbs were recently observed and are illustrated at Fig. 24.

The starch which is very abundant in the bulbs is very finely banded, the fine lines being accompanied at intervals by coarser ones. Fig. 21 shows some of the more common shapes assumed by the starch. Occasional grains are found which are greatly elongated. Often there is a crack or fissure running through the nucleus of the grain but this is not constant, especially in small or medium sized grains.

So far as known, a satisfactory explanation of the common name of *Erythronium* has not been given. Many plants have for their common names the translation of their Latin designation, and the common name will remain through many changes in nomenclature of the scientific descriptions. People seeing in a new country a plant closely resembling one familiar near their homes, usually give the new plant the name of the one already known. Hence when *Erythronium Americanum* was seen, so closely resembling the European species, it received the common name of that better known plant, dog's-tooth violet.

In the library of the U. S. Department of Agriculture at Washington, there is a copy of Leonard Fuchs' herbal: De his-

toria stirpium insignes * * * Basileae, 1542. When examining this and several other volumes in December, 1897, a description, and excellent illustration were found of the European *Erythronium*, named *Viola Dens-canis*. The *Viola* part of the name is probably due to coincidence in time and place of flowering: *Dens-canis* refers either to the shape of the bulbs, or to the dentations at the base of the petals. In another part of the same volume a number of violets are figured bearing the generic name *Viola* as now.

During the examination of old botanical works in the search for the above reference the following names were found, applied to what has been known since Linnaeus as *Erythronium Dens-canis*.

Pliny : (*Historia Mundi* ; Froben, ed. Basillae 1554), lib. 26, ch. x., p. 472, speaks of "another *Satyrion* (called *Erythraicon*), seeds like *vitex* but larger, smooth ; root hard, cortex red, enclosing white within ; sweet juice ; occurring in mountains."

Dioscorides (*Pedacii* ; Saracenus, ed. 1598), lib. 3, ch. 144, p. 232.

"*Satyrion Erythronium* or *erythraicum* has seeds resembling *linum*, but larger, firm, shining or dull. * * * The cortex of the root rather delicate, and red ; the internal portion white, juice sweet, pleasant to the mouth."

Dodoen's *Erundeboeck*, Antwerp, 1554, gives an illustration of *Satyrion erythronium*, which is probably meant to be one of the *Alliums* as some of the herbalists consider that *Allium ursinum* is referred to by Dioscorides' *Satyrion erythronium*.

Camerarius' *Kreuterbuch*, Frankfort, A. M., 1586, page 389. In this herbal *Hermodactylus* and *Pseudohermodactylus*, are figured side by side and represent *Iris* and *Erythronium* respectively. The two names are often given by the old botanists as synonyms of *Dens-canis*, or dog's-tooth, as they most frequently called it.

"*Pseudohermodactylus* is a beautiful plant, it brings two, or rarely three leaves much like the lily. It is spotted with many brown spots. Its flower grows upon a yellowish-brown stem, light purple with brown stamens (fasemen) and a white pistil (stiftlin), in the center. The little leaves [petals] unfold when the sun shines warm upon it, but when, however, they have fallen away, a three-angled knob develops full of yellow seeds. The root is longish, thicker below than above, which are often clustered together. * *

While it does not bloom it brings only one flower. It is called Dentali by Apothecers in Stiermarck."

In Lobelius' *Stirpium*, Antwerp, 1576, there is a good cut on page 64 of *Erythronium* with the brief description: "*Erythronium* with colored flowers and unequal leaves." *Satyrion Dens caninus*, *Hermodactylus* and *Pseudohermodactylus* are given as synonyms used in different regions. " * * * Flowers either purple-red or white, or purple and white mixed."

Plunkenetius (*Phytographia*, 1692, 3: 130).

"*Dens caninus*, flowers yellow, *Virginianus*." *

Salmon's *Herbal*, 1710.

"Dogs tooth * * * the same as 'satyrion having red cortex on the root,' in Dioscorides, lib. 3, ch. 144." Three color forms are described having white, red and purple flowers respectively.

Roberto Morrison, of London, in his *Plantarum Historia Oxonienis*, 1715, page 343, says that the name "*Dens canis* is from the shape of the oblong tuberous root imitating the figure of a dog's tooth, the name is good." "It has a capsule of three distinct valves. * * * When the flower is red the leaves are red spotted, when white the spots are milky."

Gronovius (*Flora Virginica*, 1739, 151, 1st edition).

"*Erythronium*, leaves oval or oblong, glabrous, dark-spotted, flowers yellow." † (Cited in Linnaeus *Spec. Pl.* 1753, as var. 7, under *E. Dens-canis*).

Gronovius' *Flore Virginia*, Lugdonum, 1762, 51 (2d edition), contains a description of our native species. "*Erythronium* with ovate oblong leaves, smooth, dark-spotted. *Dens-caninus aquatilis*, flower yellow, pendulous, leaves ovate-oblong, prostrate, two upon a stalk, glabrous, dark-spotted. Blooming toward the end of March."

The reproduction by offshoots or runners, is mentioned in Miller's *Gardener's Dictionary*, London, 1754, Vol. I., "*Dens-canis*—Dog's tooth. * * * These plants are propagated by seeds, as

* *Virginianus* is italicized, as are authors cited on the same page, but here it may be a typographical error for a reference to Virginia, since the European form has purple or red flowers.

† This is probably the first description of the American species; especially interesting, as it has the modern genus name. See previous note.

also by offsets from the old roots. * * * The offsets, which these plants produce but sparingly, should be taken off at the time that the old roots are transplanted, * * * toward the latter end of May."

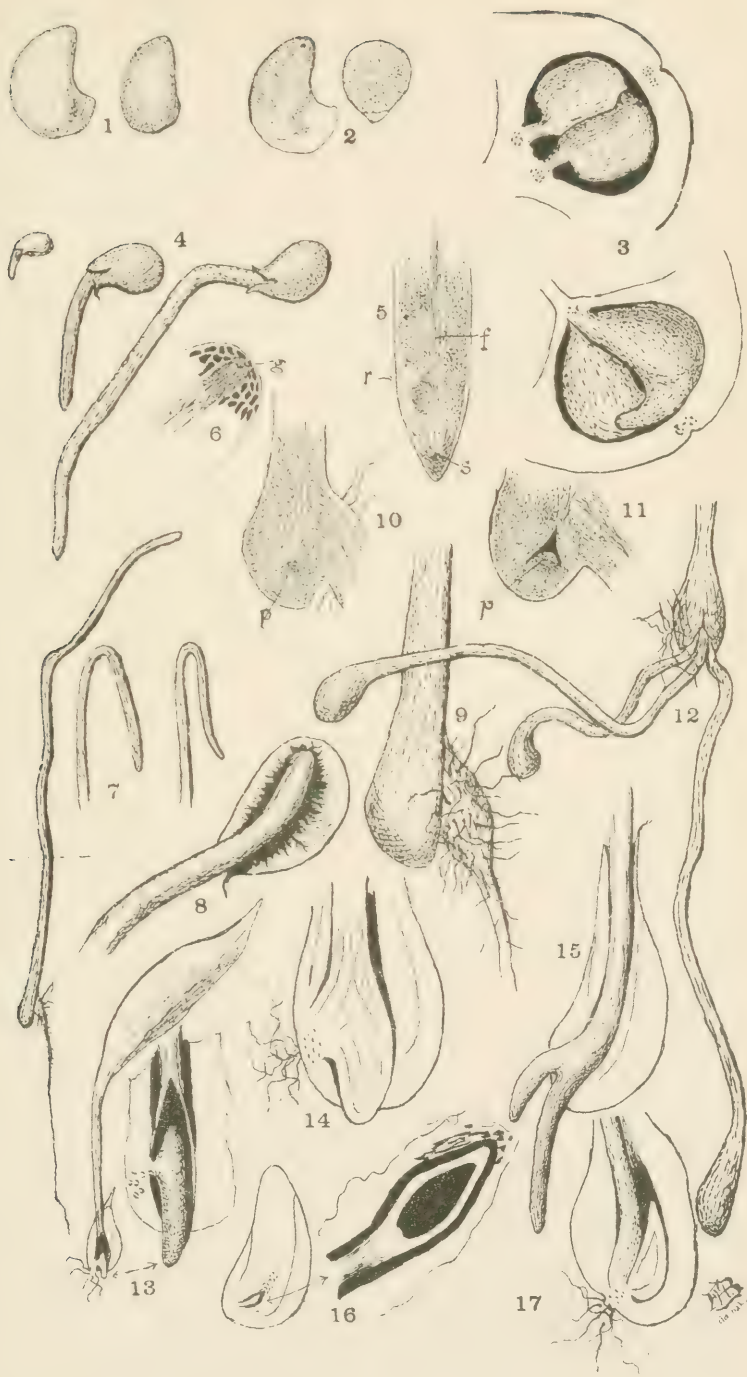
Linnaeus cites descriptions from a number of the early botanists, giving them as synonyms of his *E. Dens-canis*, or as varieties of it. Thus Dodonaeus (*Stirpium historiae pemptades*, 1616, 203) gives "*Dens caninus*" which Linnaeus regards as synonymous with *Erythronium Dens-canis*, as is also "*Dens-canis* with broad and rotund leaves," of Bauhinus (*Pinax*, Basiliae, 1671). But "*Dens-canis* with narrow and elongated leaves," of the same author is regarded as variety β under *E. Dens-canis*, and Gronovius's description given in a preceding paragraph, is ranked as variety γ in *Species Plantarum*, 1753.

Among names used or proposed for use as non-Latin designations of *Erythronium*, Trout Lily and Fawn Lily, have been suggested by John Burroughs in Riverby, on account of the spotted leaves, and because of the alert position which the two leaves often assume. Spring Lily has been proposed, on account of its early flowering, and the lily-shaped blossom. But as a colloquial name, "Roosters" is the least suggestive of the plant meant. This name is used in central New York, among the children especially, because of the custom of "fighting roosters" with the nodding flowers or buds, as is done with violets in New Jersey.

Explanation of Plates

PLATE 16

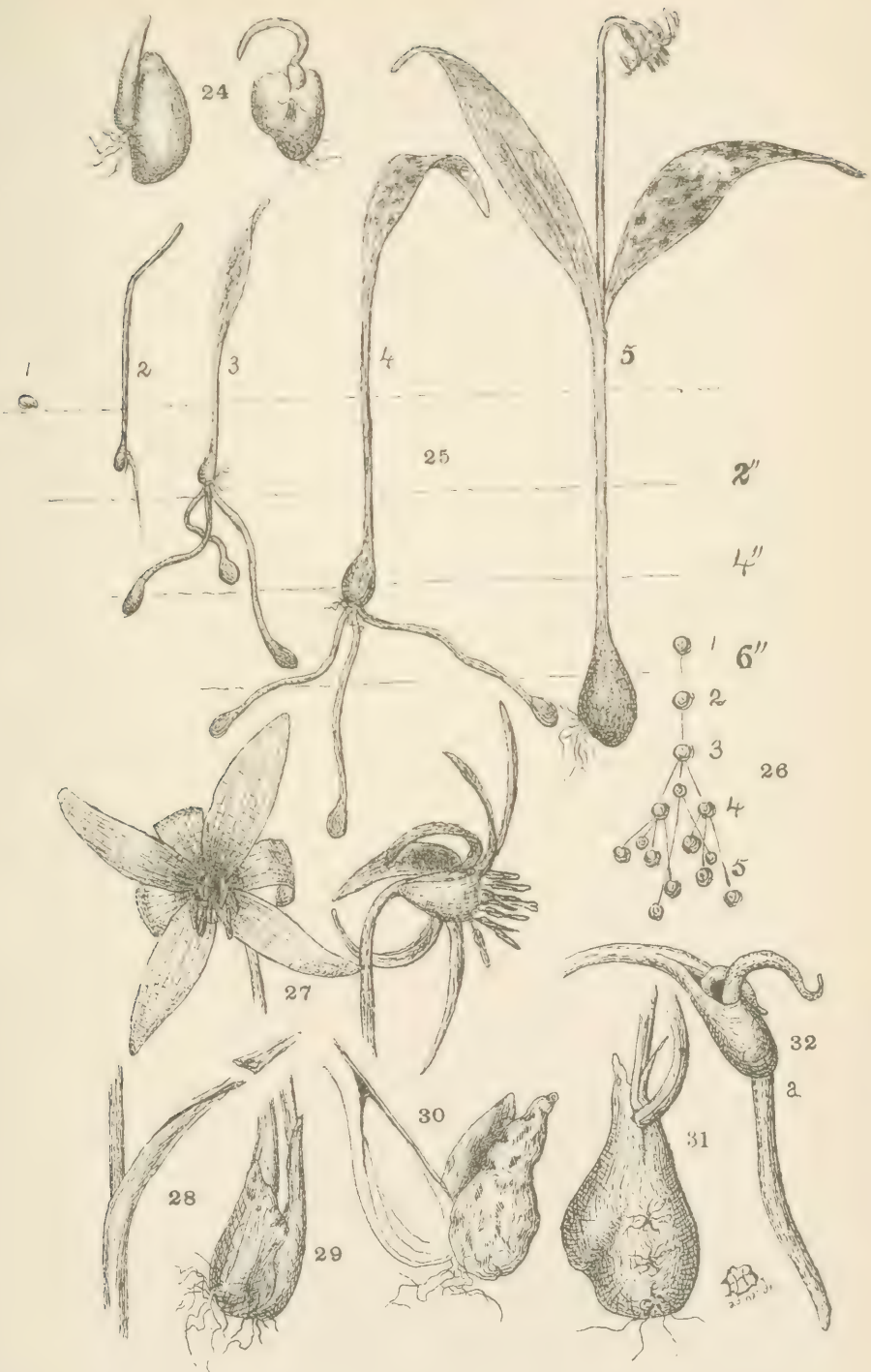
1. Surface of ripe seeds, June and March, $\times 3$.
2. Longitudinal and cross sections of seed (June), $\times 3$.
3. Cross sections of ovary, April and May, $\times 12$ and $\times 5$.
4. Successive steps in germination, $\times 1\frac{1}{2}$ and $\times 3$.
5. Longitudinal section of tip of seedling. *f*, fibrovascular bundle. *r*, point of origin of radicle. *s*, deposit of starch.
6. Tip of the cotyledon, showing the absorbing gland, $\times 10$.
7. Full grown seedlings and "elbows," $\times 1$.
8. Tip of cotyledon in partly absorbed seed, $\times 6$.
9. Base of cotyledon showing the enlarged portion which becomes a bulb (plumule-bulb), $\times 5$.
- 10, 11. Sections of young plumule bulb, plumule at *p*, $\times 5$.
12. Runners, and the developing runner bulbs, $\times 1\frac{1}{2}$.
- 13-15. Axillary buds, from which runners will develop. Slightly enlarged.
16. The first stages of the flower-and-leaves shoot (July 1).



ERYTHRONIUM AMERICANUM.



ERYTHRONIUM AMERICANUM.



ERYTHRONIUM AMERICANUM.

PLATE 17

17. Bud of annual bulb (May), $\times 1$.
18. Three sections of seed tissue. *a*, longitudinal. *b*, transverse of endosperm.
c, cells from raphe, containing scattered starch grains.
19. Longitudinal section of seed, $\times 15$.
20. Embryo in endosperm, $\times 50$.
21. Starch grains from bulb, $\times 225$.
22. Successive steps in the liberation and orientation of the flower, $\times 1$.
23. Seedling, showing the starch-bearing regions, $\times 1$.

PLATE 18

24. Surface buds on bulbs after the sprouts have been destroyed, $\times 1$.
25. Life cycle of five years, showing the successive forms assumed.
26. Diagrammatic life cycle, showing multiplication of one seed in five years.
27. Abnormal flower, petals, 7; stamens, 8; leaf, 1 (Fig. 28).
28. Leaf of 27.
29. Abnormal bulb, twinned by surface bud, $\times 1$.
30. Annual bulb turned aside to show the relation of old and new growth.
31. Mature bulb which has been three years in one place, rosettes of root fibers indicate the age, $\times 1$.
32. Stimulation growth of runner, $\times 1$.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 8

TWO NEW SPECIES OF GRIMMIA
FROM MONTANA

BY R. S. WILLIAMS

NEW YORK
1900

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, 27 : 316-317. 25 June, 1900.]

Two new Species of *Grimmia* from Montana

BY R. S. WILLIAMS

(WITH PLATES 19, 20)

Grimmia (*Eugrimmia*) *Brittoniae*

Growing in dense hemispherical tufts up to 3.5 cm. high. Stems slender, usually bearing long branches. Outer perichaetial and upper stem leaves with blade 1 mm. in length, oblong, somewhat lanceolate pointed, concave, flat on the borders with nearly smooth hair point up to 3 times the length of blade: lower leaves a little smaller with hair point scarcely equaling blade, more concave and somewhat recurved: inner perichaetial leaves minute, triangular, with hair point 8 to 10 times the length of the blade: upper cells irregular, roundish or quadratic, about .006 mm. in diameter, gradually becoming elongated below, toward base 3 or 4 times longer than broad near costa and $1\frac{1}{2}$ to 2 times longer than broad near margin: cells but slightly sinuous walled when filled with chlorophyl, later on the walls becoming distinctly sinuous both above and below: sections of costa show two large cells on ventral side with usually 5 or 6 surrounding cells, in single row, on dorsal side: leaf lamina is of a single row of cells with sometimes a doubling of one row in one or both margins: apparently dioicous: fruit unknown.

Growing on shaded perpendicular walls, partly calcareous, in rather dry places. Collected for several seasons in Bad Rock Cañon, Flathead River, Mont.

This species is dedicated to Mrs. Elizabeth G. Britton, to whom all students and lovers of our mosses will ever be indebted.

Grimmia (*Eugrimmia*?) *tenuicaulis*

In compact tufts up to 6 cm. high. Stems very slender, often thread-like, with few simple, mostly short branches: perichaetial and upper stem leaves rather broadly ovate-lanceolate, concave, revolute on borders, blade $1\frac{1}{3}$ mm. long, with rough hair point about $\frac{2}{3}$ blade in length, the papillae of point spreading, often recurved: moistened leaves erect-spreading: upper cells irregular, somewhat transversely or vertically elongated, mingled with rounded cells .004-.006 mm. in diameter: cells toward base more or less elongated rectangular, those near margin from nearly

quadratic to twice longer than broad, towards costa becoming 2-4 times longer than broad: cells apparently never distinctly sinuous walled: sections of leaf show costa with two large cells on ventral side and two rows of somewhat smaller cells on dorsal side: lamina of leaf is of one thickness of cells, usually with one or two rows doubled near costa, or sometimes somewhat distant from costa, but not doubled in margin: occasionally the leaf is hyaline nearly $\frac{1}{4}$ down from apex, the hyaline cells always elongated: evidently dioicous: sporophyte not seen.

Specimens of type collected near Neihart, Belt Mts., Mont., Sept. 21, 1891, also obtained at Marsh Lake and Dawson on the Yukon River.

Explanation of Plates

PLATE 19. *Grimmia Brittoniae*

1. Plant about natural size.
2. Upper leaf, $\times$ about 35 diam.
3. Lower stem leaf, $\times$ 35 diam.
4. Section of leaf, $\times$ 175 diam.
5. Part of perichaetium.
6. Median cells, $\times$ 350 diam.
7. Basal cells.
8. Apex of leaf from upper side, $\times$ 175 diam.
9. Inner perichaetial leaf.

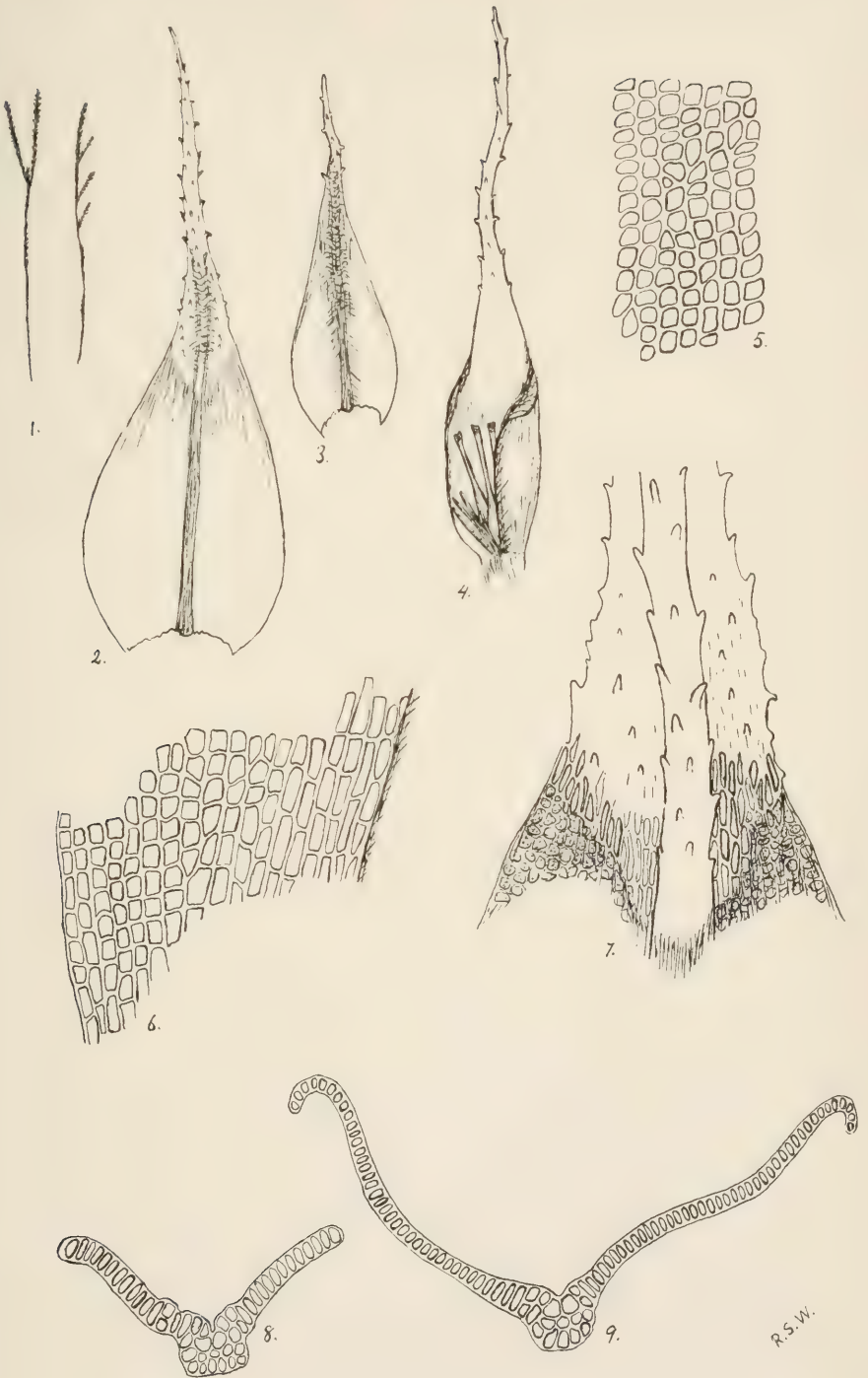
PLATE 20. *Grimmia tenuicaulis*

1. Plants about natural size.
2. Upper stem leaf, $\times$ about 35 diam.
3. Lower stem leaf, $\times$ about 35 diam.
4. Part of perichaetium.
5. Median cells, $\times$ 350 diam.
6. Basal cells, $\times$ 350 diam.
7. Apex of leaf from below, $\times$ 175 diam.
8. Section of leaf, $\times$ 175 diam.
9. Section of leaf lower down, $\times$ 175 diam.



GRIMMIA BRITTONIAE.

R. S. W.



R.S.W.

GRIMMIA TENUICAULIS.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—

No. 9

STUDIES ON THE ROCKY MOUNTAIN
FLORA—II

BY P. A. RYDBERG

NEW YORK
1900

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, 27 : 528-558. 26 Oct., 1900.]

Studies on the Rocky Mountain Flora—II

BY P. A. RYDBERG

THE ROCKY MOUNTAIN SPECIES OF MELANTHACEAE

There has been a great deal of misunderstanding regarding the species belonging to the family Melanthaceae (perhaps more commonly regarded as a sub-family of Liliaceae). Especially is this true with respect to the species growing in the Rocky Mountain region. In order that some of the confusion may be cleared up and a way may be opened to further study of the group my present views are here offered.

The family is represented in the Rockies by at least five genera and seventeen species. Of these I have found myself obliged to describe one genus and seven species as new. The genera are as follows :

TOFIELDIA Huds.

This is represented by three species, distinguished as follows :

Stem glabrous, scapose ; seeds unappendaged.

T. palustris.

Stem viscid-pubescent at least above ; seeds appendaged.

Bractlets broadly triangular, connate for two thirds of their length.

T. intermedia.

Bractlets lanceolate-triangular, connate half their length or less. *T. occidentalis.*

TOFIELDIA PALUSTRIS Huds. Fl. Ang. Ed. 2, 1 : 175

A subalpine species of wet places, growing in America from Greenland to Alaska and from the Arctic coast south to Quebec and British Columbia. It is also found in subarctic Europe. The following specimen from the Rockies is in the New York Herbaria :

BRITISH COLUMBIA : Rocky Mountains, 1890, *John Macoun.*

Tofieldia intermedia sp. nov.

Tofieldia glutinosa Hook. Fl. Bor. Am. 2 : 179, in part. 1838.
Wats. Bot. Calif. 2 : 184. Not Pursh.

A slender perennial with more or less leafy stem, 1.5–3 dm. high, viscid-pubescent above. Leaves 5–20 cm. long, 2–5 mm. wide, obtuse or acute : raceme short, dense, 1–2 cm. long : bracts

broad, ovate: pedicels usually 3 together, very short, in fruit 1-4 mm. long: bractlets under the flowers 3, broadly triangular, connate for about two thirds their length: flowers yellow: sepals obovate, 4-5 mm. long: petals somewhat narrower and longer: capsule ovoid, about 5 mm. long: beaks about 1 mm. long, spreading: seeds appendaged.

This has been confused with the eastern *T. glutinosa* Pers. which has an elongated raceme, longer pedicels, and oblong subequal sepals and petals, about 4 mm. long. All specimens from the west referred to *T. glutinosa* may belong to *T. intermedia*. At least all that I have seen do so. *T. intermedia* grows in bogs to an altitude of 2,700 m. from Saskatchewan to Alaska, British Columbia and Wyoming. The following specimens belong to it:

ALASKA: Sheh-Shooh Lake, 1895, *M. W. Gorman*, 78 (type); Yes Bay, 1895, *Thos. Howell*, 1666; Khantaak Island, 1892, *F. Funston*, 47; Sitka, *Bongard*.

BRITISH COLUMBIA: Summit of Selkirk Mountains, 1890, *John Macoun*.

WASHINGTON: Totoish Mountains, 1897, *O. D. Allen* 274.(?)

MONTANA: Flathead River, 1892, *R. S. Williams*, 915; Granite, 1892, *Kelsey*; Upper Marias Pass, 1883, *Canby*, 328.

WYOMING: Cement Creek, 1897, *F. Tweedy*, 336.

TOFIELDIA OCCIDENTALIS Wats. Proc. Am. Acad. 14: 283. 1879

This species is distinguished from the preceding by the narrower, less connate bractlets, longer pedicels, narrower sepals, larger capsule, 8 mm. long, and longer ascending beaks. The following specimen from the Rocky Mountain region is in the New York Herbaria.

BRITISH COLUMBIA: Avalanche Mountain, 1890, *J. M. Macoun*.

XEROPHYLLUM

This genus is represented by two species:

Petals and sepals 7-10 mm. long.

X. tenax.

Petals and sepals 4-6 mm. long.

X. Douglasii.

XEROPHYLLUM TENAX (Pursh) Nutt. Gen. Am. 1: 235. 1818

Helonias tenax Pursh Fl. Am. Sept. 243. 1814.

X. Douglasii Rydb. Mem. N. Y. Bot. Gard. 1: 92; not Wats.

This has been greatly confused with the following. Watson stated that *X. Douglasii* was collected on the Hayden Surveys of the Yellowstone Park, but does not cite any locality in the Rocky Mountains for *X. tenax*. Coulter in his Manual of the Rocky Mountain Region included consequently a description of the former, but none of the latter. As this book is the one most used by Rocky Mountain botanists, all specimens of *Xerophyllum* from that region have therefore been labeled *X. Douglasii*. I made the same mistake in preparing my Catalogue of the Flora of Montana. All the specimens cited there belong to *X. tenax* instead of *X. Douglasii*. Besides the Montana specimens there cited, the following Rocky Mountain specimens belong to this species :

BRITISH COLUMBIA : Toad Mountain, Kootenay Lake, 1890 *J. M. Macoun*.

IDAHO : Kootenay Co., 1888, *J. H. Saunders* ; Wiessner's Peak, 1892, *Sandberg, MacDougal & Heller*, 588.

XEROPHYLLUM DOUGLASII Wats. Proc. Am. Acad. 14 : 284. 1879.

I have not seen any Rocky Mountain specimen of this species, but include it on the authority of Dr. Watson who referred to it the specimens from the Hayden Collection mentioned above.

Stenanthella gen. nov.

Erect bulbous glabrous herbs with few narrow leaves and racemose or paniculate perfect greenish, brownish or purplish flowers. Petals and sepals each 3, subequal, withering-persistent, narrowly lanceolate, acuminate, with reflexed tips, and at last involute, without gland and distinct claw. Stamens 6, free, included ; anthers reniform, confluent 1-celled. Ovary ovoid, superior ; styles 3. Capsule lance-ovoid, 3-beaked, septicidal to the base, wholly superior. Seeds oblong, winged.

Dr. Gray included the species belonging here in *Stenanthium*, but the genus is better defined than many of the recognized genera in the family. In *Stenanthium*, the flowers are polygamous, open, not campanulate in outline, the base of the ovary is inferior, the tip of the petals and sepals not reflexed and the general habit different. The genus *Stenanthella* contains two known species, one from the island Sachalin, **S. Sachalinensis** (*Stenanthium Sachalinense* F. Schmidt), and the following :

Stenanthella occidentalis (A. Gray) Rydb. n. n.

Stenanthium occidentale A. Gray, Proc. Am. Acad. 8: 405.

The species ranges from Alberta and British Columbia to Oregon and Idaho. The following specimens are from the Rockies:

MONTANA: Deer Lodge, 1892, *Miss Emma Ware*; Flathead River, 1883, *Canby*, 332; Big Blackfoot, *Canby*; divide between Hell Gate and Blackfoot, 1880, *Watson*; Columbia Falls, 1894, *R. S. Williams*.

ALBERTA AND BRITISH COLUMBIA: Rocky Mountains, 1858, *E. Bourgeau*; Kicking Horse Lake, 1887, *John Macoun*.

IDAHO: Kootenay Co., 1890, *J. B. Leiber*, 4912.

VERATRUM L.

Flowers greenish, bractlets foliaceous, often equaling or exceeding the flowers.

V. viride.

Flowers white or yellowish white; bractlets membranous, much shorter than the pedicels and flowers.

V. speciosum.

VERATRUM VIRIDE Ait. Hort. Kew. 3: 422. 1789

V. lobelianum ♂ *Eschscholtzianum* R. & S. Syst. 7: 1555. 1829.

V. Eschscholtzii Gray, Ann. Lyc. N. Y. 4: 119. 1837.

If the western plant should be included in *V. viride* or not, is doubtful. The eastern plant extends west to Minnesota and the western is found first on the Pacific slope in Idaho and British Columbia. Both are very variable and no good character has been found to separate the two. As a rule the western plant has shorter stamens and bracts; the former scarcely half as long as the petals and sepals. The western range of *V. viride* or *V. Eschscholtzianum*, whatever name it should bear, is from southern Alaska to Oregon and Idaho. The following are the only specimens seen from the Rockies.

IDAHO: Packsaddle Peak, 1892, *Sandberg*, *MacDougal & Heller*, 863.

Veratrum speciosum sp. nov.

Veratrum Californicum Wats. Proc. Am. Acad. 14: 277; in part. 1879. Not Durand.

A stout, more or less pubescent, very leafy plant, 1-3 m. high. Leaves, except the uppermost, broadly oval, 2-3 dm. long, 1-2

dm. wide, obtuse or acute, glabrous above, finely soft-pubescent beneath, sessile and sheathing: panicle many-flowered with ascending branches: bracts lanceolate, foliaceous: bractlets membranous, yellowish, ovate, acuminate, shorter than the flowers and pedicels: petals and sepals yellowish white, oval or broadly oblanceolate, mostly obtuse, 5-7-nerved, 8-10 mm. long, 4-5 mm. wide: capsule oblong, about 3 cm. long and 12 mm. in diameter: seeds oblong, 7-8 mm. long with a wide white wing-margin.

In looking over the specimens of *V. Californicum* in the Columbia Herbarium I found one specimen collected in Oregon on the Wilkes' Expedition, which looked very unlike the rest, having a narrower and denser panicle and narrower and more acutish petals and sepals. I took it out and placed it in the cover used for the specimens not named. I found in that cover a similar specimen. On the label was given neither locality nor the collector's name; but on the sheet was pasted a paper with a tracing of the basal leaves, the description of *V. Californicum* E. Durand and some remarks, among others the words "petiole 3-4 inches long." The specimens are presumably a part of the type of *V. Californicum* or at least have been compared with Durand's specimens and the notes made by Durand himself. Durand in his description expressively states that the lower stem-leaves are petioled. As this is never the case in the plant of the northern Rockies and the Columbia Valley, I am certain that the plant generally regarded as *V. Californicum* and from which Dr. Watson's description in his revision was mainly drawn is perfectly distinct from Durand's plant. The latter is a rare plant judging from the fact that I have not seen more than the two specimens mentioned above.

V. speciosum ranges from Montana to Washington, California and Colorado, reaching a maximum altitude of 2,500 m.

MONTANA: Bridger Mountains, 1896, *Flodman*, 344 (type); Little Belt Mountains, 344½; Bozeman, *P. Koch*; Deer Lodge Co., *Emma Ware*; Belt Park, 1886, *R. S. Williams*, 475; Belt Creek, 1883, *Scribner*, 287; Lo-Lo Creek, 1880, *Watson*.

IDAHO: Lake Pend d'Oreille, 1892, *Sandberg*, *MacDougal & Heller*, 741; Kootenay Co., 1886, *J. H. Sandberg*; Lake Waha, 1896, *A. A. & E. Gertrude Heller*, 3380; 1892, *Isabel Mulford*.

UTAH: Heber Valley, 1869, *S. Watson*, 1165; American Fork Cañon, 1880, *M. E. Jones*.

WASHINGTON: 1889, *G. R. Vasey*.

OREGON: *J. S. Newberry*.

CALIFORNIA: Modoc Co., 1893, *M. S. Baker*; 1865, *H. N. Bolander*, 6255; Mt. Shasta, 1897, *H. E. Brown*.

COLORADO: Pagosa Peak, 1899, *C. F. Baker*, 258 (?). (This has smaller flowers, petals and sepals being only 6–8 mm. long.)

ZYGADENUS Michx.

Much confusion has existed in this genus. The species of Colorado, Wyoming and Montana have been variously named *Z. Nuttallii*, *Z. venenosus* and more rarely *Z. paniculatus*, but much complaint has been made that they do not fit Watson's descriptions. Some have complained that those descriptions have been too narrow, others that there is no line to be drawn between *Z. venenosus* and *Z. paniculatus* and that both those species come to near *Z. Nuttallii*. Dr. Watson's descriptions of *Z. venenosus* and *Z. paniculatus* are unusually good and correct. He knew them both from the field. The common Rocky Mountain plants belong to neither. *Z. venenosus* does not grow east of Idaho and *Z. paniculatus* not east of Utah, while *Z. Nuttallii* is a species of the plains and I doubt that it is found at all in the Rocky Mountain States. The Rocky Mountain species are distinguished as follows:

Gland obcordate; base of ovary inferior.

Petals and sepals 7–8 mm. long, 7–13-nerved.

Z. elegans.

Petals and sepals 5–6 mm. long, 3–7-nerved.

Z. Coloradensis.

Gland obovate or semi-orbicular; ovary wholly superior.

Petals and sepals more or less clawed; filaments adnate to the base of the claws.

Petals and sepals rounded or obtuse at the apex.

Upper leaves without sheaths at the base; both petals and sepals long-clawed and sub-cordate at the base*; gland with a thick margin.

Z. venenosus.

All leaves with distinct sheaths; petals long-clawed and sub-cordate at the base; sepals short-clawed; margin of the gland ill-defined.

Petals and sepals 4–5 mm. long; petals ovate; leaves 3–5 mm. wide.

Z. gramineus.

Petals and sepals 6–8 mm. long; petals oblong; leaves 5–9 mm. wide.

Z. intermedius.

Petals and sepals acute or acuminate at the apex; all leaves with sheaths; sepals cuneate at the base and short-clawed.

Leaves less than 5 mm. wide; petals and sepals both cuneate at the base and short-clawed.

Z. acutus.

Leaves over 5 mm. wide.

Raceme simple; petals long-clawed and sub-cordate at the base.

Z. falcatum.

Raceme branched; petals short-clawed, not sub-cordate at the base.

Z. paniculatum.

Petals and sepals clawless; gland obovate with a poorly defined margin; filaments free.

Z. Nuttallii.

ZYGADENUS ELEGANS Pursh, Fl. Am. Sept. 1: 241. 1814

The typical *Z. elegans* is a western plant, mainly belonging to the Rocky Mountain region, where it grows in meadows up to an altitude of 2500 m. If the eastern plant or *Z. glaucus* of Nuttall, should be included in this species, is very doubtful. It is always darker green, more glaucous, inflorescence more paniculately branched, the petals and sepals narrower and more greenish. It ranges from New Brunswick to Minnesota and south to Vermont. The range of *Z. elegans* proper is from Saskatchewan to Alaska, south to Colorado and Nevada.

Zygadenus Coloradensis sp. nov.

A rather slender glabrous plant, 2-4 dm. high. Bulb ovoid, about 2 cm. long and 1-1.5 cm. in diameter: leaves narrow, erect, about 2 dm. long, 3-5 mm. wide: flowers racemose, yellowish white-tinged with brownish or purplish: bracts linear-lanceolate, all equaling or exceeding the pedicels: petals and sepals 5-6 mm. long, 3-7-nerved, oblong or narrowly obovate, acute: capsule ovoid, 15-18 mm. long and 7-8 mm. in diameter.

Z. Coloradensis is closely allied to *Z. elegans*, differing in the smaller flowers, greener foliage, long and narrow bracts equaling or exceeding the pedicels and a brownish or purplish tint of the inflorescence, bracts and flowers. It grows in the mountains at an altitude of 2500-3500 m.

COLORADO: Idaho Springs, 1895, *Rydberg* (type); Leroux Creek, 1892, *J. H. Cowen*; La Plata, 1873, *Coulter*; Caribou, 1891, *Dr. E. Penard*; Empire, 1892, *H. N. Patterson*, 298.

ZYGADENUS VENENOSUS Wats. Proc. Am. Acad. 14: 279. 1879

This species is characterized by its narrow leaves, of which the upper lack the scarious sheaths, and by the thick, prominent

* When the petals or sepals are sub-cordate at the base and long-clawed the gland is at the very base but when they are acute at the base the gland is a little higher up on the blade.

glands. It is more slender and strict than all the species except *Z. acutus*, which is easily distinguished by its acute sepals and petals. *Z. venenosus* grows mostly on hillsides at low altitudes, scarcely ascending higher than 2000 m. It ranges from Idaho and British Columbia to California and Utah. The following Rocky Mountain specimens belong here :

UTAH: Parley's Peak, 1869, *S. Watson*, 1163.

IDAHO: Keeley's Hot Springs, 1892, *Isabel Mulford*; Big Potlash River, 1892, *Sandberg*, *MacDougal & Heller*, 319; Little Potlash River, 404.

***Zygadenus gramineus* sp. nov.**

Zygadenus venenosus Rydb. Cont. U. Dep. Ag. 3: 525. 1896. Mem. N. Y. Bot. Gard. 1: 93 in part. Not S. Wats.

A slender yellowish-green plant, 2-3.5 dm. high. Bulb elongated ovoid, 2-3 cm. long and 1-1.5 cm. in diameter: leaves narrowly linear, scabrous on the margins and the midrib, 1-2 dm. long, 3-5 mm. wide, conduplicate and somewhat falcate, all with distinct scarious sheaths surrounding the stem: racemes rather short: bracts scarious, lanceolate, long-acuminate: flowers light yellow: sepals broadly ovate, obtuse at the apex, acute at the base and very short-clawed: petals ovate, obtuse, subcordate at the base and with claws about 1 mm. long: glands almost semi-orbicular; upper margin toothed, but thin and not well defined: capsule elongated ovoid, 8-10 mm. long, 3-4 mm. in diameter.

Z. gramineus resembles somewhat the preceding, but is lower, of a yellowish color; its stem leaves are evidently sheathed, the sepals are short clawed, not subcordate at the base and the gland thin and without a distinctly thickened upper border. *Z. gramineus* grows on hillsides up to an altitude of 2500 m.; from Saskatchewan and Alberta, south to western Nebraska and Idaho.

MONTANA: Spanish Basin, 1897, *Rydberg & Bessey*, 3848 (type); 1896, *Flodman*, 343; Helena, 1891, *F. D. Kelsey*.

IDAHO: Beaver Cañon, 1895, *Rydberg*.

SOUTH DAKOTA: Hot Springs, 1892, *Rydberg*, 1051.

WYOMING: Yellowstone Park, 1888, *Dr. Chas. H. Hall*.

SASKATCHEWAN: 1858, *E. Bourgeau*.

***Zygadenus intermedius* sp. nov.**

Zygadenus venenosus Rydberg, Mem. N. Y. Bot. Gard. 1: 93 in part. 1900. Not Nutt.

A rather stout light green plant, 3-6 dm. high. Bulb elongated ovoid, about 3 cm. long and 1.5 cm. in diameter: leaves scabrous on the midrib and margins, 2 dm. or more long, 5-9 mm. wide, keeled and sometimes conduplicate; all with conspicuous scarious sheaths at the base: raceme rather long: flowers light yellow; petal and sepals 6-8 mm. long, obtuse; the former broadly ovate, and acute or rounded at the base and short-clawed; the latter oblong subcordate at the base and with a claw 1 mm. long: glands as in the preceding.

Like the preceding but taller and stouter, in habit resembling mostly *Z. paniculatus*, except that the inflorescence is seldom branched. It is easily distinguished from that species by the obtuse petals and sepals and by the distinct claws and the subcordate bases of the petals. It grows on dry hillsides up to an altitude of 2000 m. in Montana, Idaho, Wyoming and Utah.

IDAHO: Nez Perces Co., 1892, *J. H. Sandberg*, 10564 (type); Peter Creek, 1892, *Sandberg, MacDougal & Heller*, 114; Lewiston, 1896, *A. A. & E. Gertrude Heller*, 3093.

UTAH: Farmington, 1881, *M. E. Jones*, 2091.

WYOMING: Laramie Hills, 1894, *Aven Nelson*, 254.

MONTANA: Deer Lodge, 1895, *F. N. Notestein*; Bridger Mountains, 1897, *Rydberg & Bessey*, 3849.

***Zygadenus acutus* sp. nov.**

A very slender light green plant, 3-5 dm. high. Bulb rounded ovate, 1.5-2 cm. long, 1-1.5 cm. in diameter: leaves narrowly linear, scabrous on the margin, about 2 dm. long and 4-5 mm. wide, keeled and often conduplicate: flowers pale yellow: petals and sepals 4-5 mm. long; both acute at the apex and at the base, very short-clawed: glands obovate or cuneate; upper margin toothed, thin and not well defined.

In habit closely resembling *Z. venenosus*, but easily distinguished by the acute, short-clawed petals and sepals, which are both cuneate at the base. The only specimens seen are the following:

SOUTH DAKOTA: Box Elder Creek, Black Hills, 1887, *W. S. Rusby*.

***Zygadenus falcatus* sp. nov.**

Z. Nuttallii Porter & Coult. Syn. Fl. Colo. 133. In part. 1874. Not A. Gray.

A rather stout light green plant 3-4 dm. high. Bulbs rounded ovoid, 3-4 cm. long and about 3 cm. in diameter: leaves scabrous, especially on the margins and midribs, 1.5-2.5 dm. long, 5-8 mm. wide, keeled, conduplicate, and generally decidedly falcate, all with scarious sheaths: raceme short, in fruit elongated: flowers yellow: petals and sepals about 5 mm. long, acute; the former deltoid ovate, acute at the base; the latter ovate, sub-cordate at the base and with claws 1 mm. long: glands semi-orbicular, upper margin toothed, thin and not well defined: capsule ovoid cylindrical.

All the specimens cited below have been named *Z. Nuttallii* though the plant is more closely related to *Z. paniculatus*, from which it differs in the distinctly clawed petals which are subcordate at the base. These characters, together with the more distinct glands and the slightly adnate filaments, distinguish it from *Z. Nuttallii*. *Z. falcatus* inhabits the foothills of Colorado at an altitude of about 1500 m.

COLORADO: Fort Collins, 1893, *C. S. Crandall* (type); 1896. *C. F. Baker*; Denver, 1873, *J. M. Coulter*.

ZYGADENUS PANICULATUS (Nutt.) Wats. Bot. King's Exp. 5: 343,
1871

Helonias paniculata Nutt. Journ. Phila. Acad. 7: 57. 1834.

It is well characterized by Watson and easily distinguished by its stout habit, generally branched inflorescence, and rhombic-ovate acute and almost clawless petals and sepals. It grows on hills up to an altitude of 1500 m., ranging from Montana and Washington to New Mexico and California. The following Rocky Mountain specimens belong here:

UTAH: Ogden, *Capt. Stansbury*; City Creek Cañon, 1880, *M. E. Jones*, 1674.

IDAHO: Boise, 1892, *Isabel Mulford*.

MONTANA: Grasshopper Valley, 1880, *Watson* (?).

ZYGADENUS NUTTALLII A. Gray, in Wats. Proc. Am. Acad. 14: 279-
1879

Amianthium Nuttallii Gray, Ann. Lyc. N. Y. 4: 123.

This is evidently a species belonging to the plains. All the specimens in the Columbia and N. Y. Botanical Garden herbaria are from Arkansas and Kansas. Dr. Watson included Texas and

Colorado in the range. The Texan plant referred here by him, belongs to an altogether different plant. I think that Colorado also should be excluded, believing that all specimens found there and labeled *Z. Nuttallii* belong to *Z. falcatus*, which resembles it most in general habit, but has an altogether different flower.

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STUDIES ON THE ROCKY MOUNTAIN
FLORA—III

BY P. A. RYDBERG

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Studies on the Rocky Mountain Flora.—III

BY P. A. RYDBERG

SOME SMALLER GENERA OF COMPOSITES

STENOTUS Nutt.

This genus was established by Nuttall in 1840. It was retained as a genus by Torrey and Gray in their Flora, but merged with several others into *Aplopappus* by Gray in his Synoptical Flora. A few years ago (1894), Professor Greene reestablished the genus, removing from it, however, a member erroneously placed in the genus by Torrey and Gray, viz., *Stenotus pygmaeus* Torrey and Gray (*Aplopappus pygmaeus* Gray), which he referred to *Macronema*.^{*} If such a transfer was the very best is questionable, for that species is as much a stranger in *Macronema* as it is in *Stenotus*. It has the outer bracts foliaceous and the style-appendages long and attenuated which are characters found in *Macronema*; but the habit is very unlike *Macronema* and the outer foliaceous bracts are numerous as in *Pyrrocoma*. I had some transient thought of transferring it to that genus; but the purely white pappus, the densely cespitose habit, and the lack of the thick taproot, debar it from *Pyrrocoma*. These characters ally it to *Solidago*; but the difference in structure of the outer and the inner bracts makes it unnatural to place it there as well. It is very hard to decide which would be the best course to take, either to place it as an anomalous member of one of these genera or to make it the type of a new genus. Perhaps some other and better relationship may be found.

Of the other species included in APLOPAPPUS § STENOTUS by Gray, *A. Parryi* is, I think, rightly referred to *Solidago*. *A. Lyallii* was altogether omitted by Professor Greene, when he made the segregation in Pittonia. He may have overlooked this, but it is more probable that he omitted it, because he did not know where to place it. The relationship is without any doubt closest with *Solidago*, notwithstanding the solitary head.

^{*} In a recent distribution of plants from Colorado determined by Professor Greene, this was distributed under its original name *Stenotus pygmaeus*.

By removing *Stenotus linearifolius* Torr. & Gray and *S. interior* Greene, which constitute a good genus, the genus *Stenotus* becomes a very natural one, with only one somewhat aberrant member, *S. lanuginosus* which approaches *Pyrrocomma inuloides* and its relatives in habit.

The Rocky Mountain species are distinguished as follows:

Plant glabrous or puberulent; leaves firm and evergreen.

Leaves linear to filiform.

1. *S. stenophyllus*.

Leaves mostly oblanceolate.

Bracts lanceolate, acute.

Plant puberulent.

Bracts in 3 series, broad, with broad scarious margins.

2. *S. acaulis*.

Bracts in 2 series, narrow, with narrow scarious margins.

3. *S. Andersonii*.

Plant glabrous.

Stem-leaves oblanceolate, 1-2 cm. long.

4. *S. caespitosus*.

Stem-leaves linear, 4-7 cm. long.

5. *S. falcatus*.

Bracts oval or oblong, very obtuse.

6. *S. armerioides*.

Plant floccose; leaves softer, not evergreen.

7. *S. lanuginosus*.

1. *STENOTUS STENOPHYLLUS* (A. Gray) Greene, *Erythea*, 2 : 72.
1894

Aplopappus stenophyllus A. Gray, U. S. Expl. Exp. 17 : 347.
1862-74.

This species grows on stony hills and mountains and ranges from western Idaho and Washington to California.

2. *STENOTUS ACAULIS* Nutt. Trans. Am. Phil. Soc. II. 7 : 334.
1840

Chrysopsis acaulis Nutt. Journ. Phil. Acad. 7 : 33. 1834.

Aplopappus acaulis A. Gray, Proc. Am. Acad. 7 : 353. 1867.

This is a rather common species, growing on dry rocky hills and mountains at an altitude of 1000-2500 m., from Saskatchewan and Washington to Wyoming and California.

3. *Stenotus Andersonii* sp. nov.

A puberulent, caespitose, but less woody perennial than the preceding and the three next following species. Flowering stems about 1 dm. high, leafy at the base, few-leaved above: leaves narrowly oblanceolate, not very rigid, distinctly 3-ribbed, 3-5 cm. long, 3-4 mm. wide: bracts narrowly lanceolate, acute, glandular

puberulent, with a very narrow scarious margin, imbricated in 2 series: achenes somewhat fusiform, about 4 mm. long, grayish or white villous as in the other species.

This species is nearest related to the preceding, but characterized by the less rigid leaves, the fewer and narrower involucre bracts, the involucre being more that of *S. lamuginosus*.

The type was collected on dry open hills.

MONTANA: Belt Mountains, 1886, *E. W. Anderson*, 3561.*

4. *STENOTUS CAESPITOSUS* Nutt. Trans. Am. Phil. Soc. II. 7: 335.
1840

Chrysopsis caespitosa Nutt. Jour. Acad. Phila. 7: 33. 1834.

- Aplopappus acaulis* var. *glabratus* D. C. Eaton, King's Exped.
5: 161. 1871.

This grows on dry hills and mountains, at an altitude of 1000–3000 m., from Montana and Idaho to Nevada, Arizona and Wyoming.

5. *Stenotus falcatus* sp. nov.

A glabrous caespitose perennial, with a woody caudex, resembling *S. armerioides* in habit. Flowering stems 10–15 cm. high, leafy, 1–3-cephalous: basal leaves oblanceolate, rigid, obtuse or acute, 4–5 cm. long, 4–6 mm. wide, 3-ribbed; stem leaves linear, 4–7 cm. long, 2–3 mm. wide, more or less falcate: heads about 1 cm. high: bracts lanceolate, acute, with scarious margin: rays 6–7 mm. long, 2.5–3 mm. wide.

This species differs from *S. armerioides*, which it closely resembles in the narrower and acute involucre bracts. It grows in barren soil at an altitude of about 1500 m.

UTAH: Red Creek, 1877, *Dr. E. Palmer*, 202 (type); Milford, 1880, *M. E. Jones*, 1804.

6. *STENOTUS ARMERIOIDES* Nutt. Trans. Am. Phil. Soc. II. 7:
335. 1840

Aplopappus armerioides A. Gray, Syn. Fl. 1²: 132. 1884.

This species grows on dry hills and bad-lands, at an altitude of 1000–2000 m., from Manitoba and Assiniboia to Utah, New Mexico and western Nebraska.

* Unless otherwise stated, the types of the new species described are preserved in the herbaria of the New York Botanical Garden or of Columbia University.

7. *STENOTUS LANUGINOSUS* (A. Gray) Greene, *Erythea*, **2**: 72.
1894.

Aplopappus lanuginosus A. Gray, U. S. Expl. Exped. **17**: 347.
1862-74.

This species is a rather anomalous member of the genus, as the leaves are not rigid, and scarcely evergreen. In habit it resembles somewhat some species of *Pyrrocoma*, as for instance, *P. inuloides*; but it has the thin involucre bracts and the white pappus of *Stenotus*. It grows on the mountains of Washington, northern Idaho and Montana.

Stenotopsis gen. nov.

Low shrubs with fastigiate branches, narrow fasciculate glandular punctate leaves and large peduncled heads. Involucre broadly hemispherical; its bract subequal, almost in a single series, linear lanceolate, thin scarious-margined, not at all herbaceous. Receptacle naked, alveolar. Ray-flowers about 12, ligulate, yellow, large, pistillate and fertile. Disk-flowers perfect: their corollas tubular-trumpet shaped, deeply 5-lobed. Anthers obtuse at the base. Style branches stigmatic their whole length, with ovate to lanceolate-subulate appendages. Achenes densely silvery-villous. Pappus of white capillary bristles, rather deciduous.

The genus contains two known species. It differs mainly from *Stenotus* in its shrubby habit and glandular punctate leaves.

Leaves 3-4 cm. long; rays 11-14 mm. long.

1. *S. linearifolius*.

Leaves 1-2 cm. long; rays 9-11 mm. long.

2. *S. interior*.

1. Stenotopsis linearifolia (DC.)

Aplopappus linearifolius DC. Prod. **5**: 347. 1836.

Stenotus linearifolius Torr. & Gray, Fl. N. Am. **2**: 238. 1842.

This species is a shrub 3-10 dm. high, and grows on dry hills, from Utah to California and Arizona.

2. Stenotopsis interior (Coville)

Aplopappus interior Coville, Proc. Biol. Soc. Wash. **7**: 65.
1892.

Stenotus interior Greene, *Erythea*, **2**: 72. 1892.

Its range is further southwest, from southern Utah to Arizona and southern California.

MACRONEMA Nutt.

This genus was also established by Nuttall in 1840 and re-established by Greene. The latter included, as is stated before, also *Stenotus pygmaeus* Nutt. (*Aplopappus pygmaeus* A. Gray). As the relationship of that species is rather doubtful, I have not included it in the treatment below. The species can be separated as follows:

Heads radiate.

Heads small, fastigate clustered; disk 5-8 mm. in diameter.

Leaves broadly obovate, mucronate-cuspidate. 1. *M. obovatum*.

Leaves oblanceolate, acute or pointed. 2. *M. Watsonii*.

Heads larger, solitary: disk 1 cm. or more in diameter.

Leaves oblanceolate, acute. 3. *M. suffruticosum*.

Leaves spatulate, obtuse or mucronate. 4. *M. grindelifolium*.

Heads discoid.

Leaves oblong-oblanceolate.

Outer bracts oblong, acute. 5. *M. discoideum*.

Outer bracts broadly oblong, obtuse. 6. *M. obtusum*.

Leaves linear.

7. *M. lineare*.

 1. *Macronema obovatum* sp. nov.

A glandular-puberulent undershrub, 2-3 dm. high, with light yellow bark on the branches. Leaves broadly obovate, 1-2 cm. long, 7-10 mm. wide, mucronate-cuspidate: heads usually 2-3 together, about 10 mm. high, and 8 mm. broad: its bracts firmer than in the other species, oblong-linear, abruptly obtusate-acute at the apex, unequal, imbricated in about 4 series: rays short, 4-5 mm. long and 1-1.5 mm. wide, about 10 in number.

The species is nearest related to *M. Watsonii*, differing mainly in the broad leaves and the abruptly acute bracts. The type was collected at an altitude of 1600 m.

UTAH: City Creek Cañon, *M. E. Jones*, 1081.

 2. *MACRONEMA WATSONII* (A. Gray) Greene, *Erythea*, 2: 74.
1894

Aplopappus Watsonii A. Gray, Proc. Am. Acad. 16: 79. 1881.

This grows on mountains at an altitude of 2000-2500 m., in Utah and Nevada.

 3. *MACRONEMA SUFFRUTICOSUM* Nutt. Trans. Am. Phil. Soc. II.
7: 322. 1840

Aplopappus suffruticosus A. Gray, Proc. Am. Acad. 6: 542.
1865.

This species grows in the mountains of Oregon and California up to an altitude of 3000 m. It has also been reported from Wyoming, but possibly some specimens of the next have been mistaken for it.

4. *MACRONEMA GRINDELOIDES* Rydberg, Mem. N. Y. Bot. Garden, **1**: 384. 1900

The habitat of this species is rocky places on mountain-sides, at an altitude of 2500–3000 m. It grows in Montana, Idaho and northern Wyoming.

5. *MACRONEMA DISCOIDEUM* Nutt. Trans. Am. Phil. Soc. II. **7**: 322. 1840

Aplopappus Macronema A. Gray, Proc. Am. Acad. **6**: 542. 1864.

This species grows on the higher mountains at an altitude of 2500–3000 m., from Wyoming and Colorado to California.

6. *Macronema obtusum* sp. nov.

A dense glandular-pubescent undershrub, 2–4 m. high, with white-tomentose branches. Leaves oblong-ob lanceolate, about 3 cm. long and 6 mm. wide, obtuse or mucronate: heads about 18 mm. high, 10–18 mm. in diameter: their bracts linear, acute, scarcely more than half as long as the flowers, subequal, except the outermost, which are foliaceous, broadly oblong, obtuse or mucronate: rays none.

The species is closely related to the preceding, differing in the stouter habit and the larger and broader, more obtuse outer bracts. It grows on high mountains at an altitude of about 2500 m.

COLORADO: South Cottonwood Gulch, 1892, *C. S. Sheldon*, 5838 (type); Twin Lakes, 1873, *John Wolfe*, 451.

7. *MACRONEMA LINEARE* Rydb. Mem. N. Y. Bot. Garden, **1**: 384. 1900

In habit, this species resembles some species of *Chrysothamnus* and Prof. Aven Nelson insists that it should be referred to that genus. It has, however, the foliaceous outer bracts and long style-appendages of *Macronema* and is clearly congeneric with the two preceding species. It cannot very well be referred to *Chrysothamnus*, for it lacks the most essential character of the genus, viz., the

arrangement of the involucre bracts in distinct vertical rows. It grows in gravelly places in northern Wyoming, at an altitude of 2000–2500 m.

SIDERANTHUS Fraser

The name *Sideranthus* appears first in Fraser's Catalogue, but there only as a nomen nudum. Pursh in his Flora on page 750 gives *Sideranthus integrifolius* Fraser and *S. pinnatifidus* Fraser as synonyms of *Amellus villosus* and *A. spinulosus* described on page 564. There may be a doubt as to which of these should be regarded as the type of *Sideranthus*. *Amellus villosus* with its relatives was made a genus *Chrysopsis* by Nuttall in 1818 or by Elliott in 1824, according to different interpretations, long before *Eriocarpum* was established (1840). This leaves *Sideranthus pinnatifidus* as the residue of the genus *Sideranthus*. Besides Nuttall, who was the real author of Fraser's Catalogue, made *Sideranthus* a subgenus of *Dictyria* containing the only species *D. spinulosa* (*Aplopappus spinulosus* DC. See Trans. Am. Phil. Soc. II. 7: 301); and thus shows that he regarded it as the type of *Sideranthus*.*

Leaves spinescent toothed, not pinnatifid.

Heads discoid; perennial with woody caudex.

1. *S. grindelioides*.

Heads radiate; annual.

2. *S. rubiginosus*.

Leaves pinnatifid.

Stem more or less floccose, or cinereous especially when young.

Plant cinereous pubescent, more or less glandular.

3. *S. australis*.

Plant more or less floccose, not at all glandular.

4. *S. spinulosus*.

Plant neither floccose nor cinereous.

Plant perfectly glabrous or sparingly glandular puberulent.

5. *S. glaberrimus*.

Plant finely puberulent.

Heads hemispherical; bracts slightly glandular.

6. *S. puberulus*.

Heads somewhat turbinate; bracts densely glandular puberulent.

7. *S. turbinellus*.

1. *Sideranthus grindelioides* (Nutt.) Britton

Eriocarpum grindelioides Nutt. Trans. Am. Phil. Soc. II. 7:

321. 1840.

Aplopappus Nuttallii Torr. & Gray, Fl. N. A. 2: 240. 1842.

* Professor Greene (Pittonia 2: 115) seems to think *Sideranthus* is derived from the Latin *sidus*, star, and the Greek, *ανθος*, flower. It is better to regard the first part also as Greek, *σιδηρος*, iron. Why accuse Nuttall of making a hybrid word, which we would not permit ourselves?

The species is not uncommon on barren hills and in bad-lands, up to an altitude of 1500 m. Its range extends from Saskatchewan and western Nebraska to Colorado and Arizona.

2. **Sideranthus rubiginosus** (Torr. & Gray) Britton

Aplopappus rubiginosum Torr. & Gray, Fl. N. Am. 2: 240. 1842.

Eriocarpum rubiginosum (Torr. & Gray) Britton, Mem. Torr. Bot. Club, 5: 316. 1894.

The species was first described as a perennial. Our plant is evidently only annual. Possibly two different species have been confused under the name *E. rubiginosum*. It grows in sandy soil from Texas to Colorado and western Nebraska, reaching an altitude of 1500 m.

3. **Sideranthus australis** (Greene)

Eriocarpum australe Greene, Erythea, 2: 108. 1894.

This grows on the plains of western Texas, Colorado, New Mexico and Mexico.

4. **SIDERANTHUS SPINULOSUS** (Pursh), Sweet, Hort. Brit. 227. 1826

Amellus spinulosus Pursh, Fl. Sept. Am. 564. 1814.

Sideranthus pinnatifidus Fraser; Pursh, Fl. Am. Sept. 750. 1814

Aplopappus spinulosus DC. Prod. 5: 347. 1836.

Eriocarpum spinulosum (Pursh) Greene, Erythea, 2: 108. 1894.

The species is rather common on plains and dry prairies, from Saskatchewan, Nebraska and Texas to Mexico, Arizona and Idaho.

5. **Sideranthus glaberrimus** sp. nov.

Perennial, with a short woody caudex, perfectly glabrous, or very sparingly glandular-puberulent. Stems several, branched above, very leafy, 1-3 dm. high: leaves rather rigid, about 2 cm. long, bluish green, glabrous, pinnatifid; segments oblong, 2-5 mm. long and 1 mm. or less wide, spinulose-tipped: heads numerous, corymbose, depressed hemispherical, 8-10 mm. high and 8-15 mm. broad: bracts imbricated in 6-7 series, the outer gradually shorter, firm, appressed, with a herbaceous tip, acute; the inner tinged with purplish: rays about 20, 4-5 mm. long and about 1 mm. wide.

The species is closely allied to the preceding, differing mainly in the total lack of tomentum, even when young, the bluer color and the smaller, generally purple-tinged bracts. It grows on plains and hills, from Iowa and Indian Territory to New Mexico and Wyoming.

KANSAS : Osborn City, 1894, *C. L. Shear*, 116 ; Harper, 1888, *W. A. Kellerman* ; Hamilton Co., 1895, *Hitchcock*, 222.

NEBRASKA : 1893, *Rydberg*, 1403a (type) ; *G. D. Swezey*, 55.

INDIAN TERRITORY : 1868, *Edward Palmer*, 442.

COLORADO : Platte, *Dr. James*.

WYOMING : Platte, *Fremont*, Dayton, 1899, *Tweedy*, 2076.

6. *Sideranthus puberulus* sp. nov.

A low densely puberulent perennial, less than 1.5 dm. high : Stems ascending, branched above : leaves 2-3 cm. long, pinnatifid or bipinnatifid ; segments 1-5 mm. long, less than 1 mm. wide, spinulose-tipped : heads 2-4 in a small corymb, hemispherical, 8-9 mm. high, 10-12 mm. broad : bracts narrowly linear-lanceolate, appressed, acute, with small herbaceous tips, finely puberulent, but only slightly glanular : rays about 20, 8-9 mm. long and about 1.5 mm. wide.

This is perhaps nearest related to *E. australe* ; but is easily distinguished by the fine pubescence.

COLORADO : Salida, *Mrs. C. B. Clarke*, 174.

7. *Sideranthus turbinellus* sp. nov.

A low and bushy puberulent perennial, 1.5-2 dm. high. Stems corymbosely branched and very leafy : leaves .5-2 cm. long, pinnatifid or the upper reduced and merely toothed ; segments narrow, 1-5 mm. long, about .5 mm. wide : heads numerous, small, hemispherical-turbinate, 7-8 mm. high, and scarcely as broad : bracts imbricated in 6-7 series, linear-lanceolate, acute, appressed glandular-puberulent : rays 10-15, 7-8 mm. long and 1.5 mm. wide.

Perhaps nearest related *E. spinulosum*, the species is easily known by the small, somewhat turbinate heads and the dense and fine pubescence.

IDAHO : Pocatello, 1892, *A. Isabel Mulford*.

PYRROCOMA Hook.

This genus was established by Hooker in 1840, and based on one species, *P. carthamoides*. In 1894, Professor Greene extended the genus so as to include the genus *Homopappus* of Nuttall, the difference between the two genera being only that the ligules of the ray-flowers in the former are very small and inconspicuous or wanting.

Heads apparently discoid, the sterile rays being concealed in the pappus.

Inner bracts recurved cuspidate.

1. *P. subsquarrosa*.

Bracts not recurved cuspidate.

Bracts oblong or oval; heads hemispherical.

Leaves and bracts more or less spinulose-toothed, the latter with a narrow scarious margin.

2. *P. carthamoides*.

Leaves and bracts not spinulose-toothed, the latter with a broad scarious erose margin.

Pappus sordid; plant almost glabrous.

3. *P. rigida*.

Pappus brownish red; plant villous.

4. *P. erythropappa*.

Bracts lanceolate; head campanulate-turbinate.

5. *P. Cusickii*.

Heads distinctly radiate.

Bracts except the innermost obtuse, obovate or oblong.

6. *P. crocea*.

Bracts mostly acute or acuminate.

Plant not glandular.

Heads large; disk 2 cm. or more in diameter; bracts in about 3 series.

Upper part of stem and involucre decidedly villous; bracts wholly foliaceous.

Bracts oblanceolate, abruptly acute.

7. *P. Clementis*.

Bracts lanceolate, long-acute.

8. *P. villosa*.

Stem and involucre almost glabrous; bracts chartaceous at the base with foliaceous tips.

9. *P. integrifolia*.

Heads smaller; disk less than 2 cm. in diameter.

Bracts in 2-3 unequal series.

Leaves 5-15 mm wide; disk 1-2 cm. wide.

Inflorescence corymbiform; bracts long-acute.

10. *P. lanceolata*.

Inflorescence racemiform; bracts abruptly acute.

11. *P. Vaseyi*.

Leaves 2-4 mm, wide; disk 1 cm. or less wide.

12. *P. tenuicaulis*.

Bracts nearly of the same length.

Stem-leaves oblanceolate; bracts long-acuminate.

13. *P. acuminata*.

Stem-leaves lanceolate; bracts acute or short-acuminate.

Plant villous.

14. *P. inuloides*.

Plant, except the upper parts, glabrate in age.

15. *P. uniflora*.

Plant decidedly glandular.

16. *P. hirta*.

1. PYRROCOMA SUBSQUARROSA Greene, Erythea, 3: 22. 1895

I have seen no specimen of this species; but the description indicates a plant wholly unlike the other species of the Rocky Mountains, that I do not hesitate in accepting it as a good species. The type of *P. subsquarrosa* was collected in northern Wyoming, by Dr. J. N. Rose in 1893.

2. PYRROCOMA CARTHAMOIDES Hook. Fl. Bor. Am. 1: 307. 1833

Aplopappus carthamoides A. Gray, Proc. Acad. Sci. Phila. 1863: 65. 1864.

As treated by Dr. Gray, *A. carthamoides* comprises more than one species, and probably both of the two following species are covered by his description. There is no doubt, however, as to which species shall bear the name, for Hooker's description and figure point clearly to the plant with more or less spinulose-toothed leaves and bracts. The latter are also longer, narrower and more acute than in the other two species. *P. carthamoides* ranges from Alberta and British Columbia to Oregon and Idaho.

3. *Pyrrocoma rigida* sp. nov.

A perennial with a thick woody tap-root. Stems 1-3, erect or ascending, finely pubescent when young, glabrate in age, 2-4 cm. high, leaves pale bluish green, firm, oblanceolate, acute, entire-margined, finely puberulent, or glabrate; the lower petioled, 8-15 cm. long, 1.5-3 cm. wide; the upper smaller and sessile: heads apparently discoid, 15-20 mm. high, 15-25 mm. broad: bracts very firm, imbricated in 3-4 series, broadly oblong, acute or mucronate; the inner at least with broad scarious or semi-chartaceous margins, which generally are erose, but not spinulose-dentate: ligules of the ray-flowers erect, slightly longer than the light brownish or sordid pappus: achenes glabrous, shining.

In general habit, this species resembles closely *P. carthamoides* but has broader leaves and bracts, paler foliage and no indication of spinulose tothing. It grows in sandy places and meadows in Idaho, Montana and Washington.

IDAHO: Granite Station, Kootenay County, 1892, *Sandberg, MacDougal & Heller*, 785 (type).

MONTANA: Columbia Falls, 1894, *R. S. Williams*.

WASHINGTON: Loomiston, 1897, *A. D. E. Elmer*, 603.

4. *Pyrrocoma erythropappa* sp. nov.

A finely villous pubescent perennial. Stem 1.5-3 dm. high, with 1-4 heads: stem-leaves 3-6 cm. long, 1-1.5 cm. wide, firm, oblanceolate or oblong, acute, subsessile, finely pubescent, or glabrate on the upper surface: heads very short-peduncled in the axils of the upper leaves, 10-15 mm. high, about 15 mm. in diameter: bracts imbricated in 4-5 series, pubescent, broadly oval or oblong, obtuse, mucronate, or the outer acute, with a thin erose margin: pappus intensely brownish red: otherwise as the preceding.

IDAHO: Clear Water, *Rev. Spalding* (type in Torrey Herbarium).

5. PYRROCOMA CUSICKII (A. Gray) Greene, *Erythraea*, 2: 59. 1894
Aplopappus carthamoides var. *Cusickii* A. Gray, Syn. Fl. 2¹:
 126. 1886.

The range of this species is limited to Oregon and western Idaho.

6. PYRROCOMA CROCEA (A. Gray) Greene, *Erythraea*, 2: 69. 1894
Aplopappus croceus A. Gray, Proc. Acad. Sci. Phila. 1863: 65.
 1864.

This species is not uncommon in the mountain regions of Colorado at an altitude of 1800–3000 m.

7. *Pyrrocoma Clementis* sp. nov.

A perennial with more or less villous ascending stem, 1.5–4 dm. high: lower stem-leaves linear-oblong, about 1 dm. long, somewhat fleshy, glabrous except the ciliate margin, saliently dentate; the upper lanceolate or ovate-lanceolate, more or less auricled at the base, dentate or entire-margined; heads solitary; disk about 15 mm. high and 2.5–3 cm. broad: bracts all foliaceous, imbricated in 3–4 series, but the outer almost equaling the inner, oblanceolate, abruptly acute, villous: rays 10–12 mm. long and 2–3 mm. wide, bright yellow: achenes sparingly strigose-hirsute: pappus yellowish white.

COLORADO: Mt. Harvard, 1896, *Frederick Clements*, 44.

8. *Pyrrocoma villosa* sp. nov.

A low perennial with a thick woody tap-root. Stems 1–3, ascending, 1–1.5 dm. high, purplish, more or less villous, especially above: basal leaves oblanceolate, 7–10 cm. long, 1–1.5 cm. wide, somewhat glaucous and rigid, entire-margined or occasionally slightly spinulose denticulate; stem-leaves linear-lanceolate, 2–4 cm. long: heads solitary: disk about 2 cm. broad: bracts foliaceous, imbricated in 3–4 series, but the outer fully as long as the inner, broadly linear or lanceolate, long-acute, more or less villous: rays about 1 cm. long and 2 mm. wide: achenes glabrous: pappus dirty white.

In habit this species resembles most *P. uniflora* and *P. inuloides*; but is easily distinguished by the larger heads and the foliaceous bracts in several series. It grows in meadows at an altitude of about 2700 m.

WYOMING: Willow Creek, Big Horn Mountains, 1899, *F. Tweedy*, 2063.

9. PYRROCOMA INTEGRIFOLIA (Porter) Greene, Erythea, 2: 69. 1894
Aplopappus integrifolius Porter; A. Gray, Proc. Am. Acad.
 16: 79. 1881.

This species grows in meadows, at an altitude of 1000-2500 m., from Saskatchewan to Idaho and Wyoming.

***Pyrrocoma integrifolia pumila* var. nov.**

Pyrrocoma Howellii Rydb. Mem. N. Y. Bot. Garden, 1: 382.
 1900. Not A. Gray.

Stem low, 1 dm. or less, monocephalous; bracts shorter and less acute.

MONTANA: Butte, 1895, *Rydberg*, 2808.

10. PYRROCOMA LANCEOLATA (Hooker) Greene, Erythea, 2: 69.
 1894

Donia lanceolata Hook. Fl. Bor. Am. 2: 25. 1834.

Aplopappus lanceolatus Torr. & Gray, Fl. N. Am. 2: 241. 1842.

The range of this species is from Saskatchewan to British Columbia, Nevada and Wyoming. It ascends to an altitude of 2000 m.

11. *Pyrrocoma Vaseyi* (Parry)

Aplopappus lanceolatus var. *Vaseyi* Parry; D. C. Eaton, King's Exped. 5: 160. 1871.

I believe that this deserves a specific rank, as the racemose disposition of the heads is accompanied with shorter, closer and oblanceolate, abruptly acute bracts. It ranges from Saskatchewan (according to Gray) south to Utah and Colorado.

12. PYRROCOMA TENUICAULIS (D. C. Eaton) Greene, Erythea, 2:
 69. 1894

Aplopappus tenuicaulis D. C. Eaton, King's Exped. 5: 160.
 1871.

Aplopappus lanceolatus var. *tenuicaulis* A. Gray, Syn. Fl. 2¹:
 129. 1884.

This grows in alkali meadows of Utah, Nevada and Oregon, at an altitude of about 2000 m.

13. *Pyrrocoma acuminata* sp. nov.

A low finely villous perennial with a woody tap-root. Stems several, slender, about 1 dm. high, monocephalous: leaves nar-

rowly linear-oblongate, with strong midrib, 2-4 cm. long, 2-4 mm. wide, entire-margined, acute, finely villous on both sides: heads on naked peduncles, which are 3-4 cm. long: disk about 1 cm. high and 12-15 mm. broad: bracts in about 2 series, broadly lanceolate, contracted into a long slender tip: rays about 1 cm. long and 1.5 mm. wide: achenes pubescent: pappus tawny.

In habit this species resembles most *P. inuloides*, but differs in the smaller leaves, the shorter pubescence and the acumination of the bracts.

WYOMING: Fort Bridger, 1873, *Dr. J. V. Carter* (type in Columbia Herbarium).

14. PYRROCOMA INULOIDES (Hook.) Greene, *Erythea*, 2: 60. 1894

Donia inuloides Hook. Fl. Bor. Am. 2: 25. 1834.

Aplopappus inuloides Torr. & Gray, Fl. N. Am. 2: 241. 1842.

Dr. Gray included this in *A. uniflorus*, but I agree with Professor Greene that it ought to be kept distinct. It ranges from Montana to Idaho and Wyoming.

15. PYRROCOMA UNIFLORA (Hook.) Greene, *Erythea*, 2: 60. 1894

Donia uniflora Hook. Fl. Bor. Am. 2: 25. 1834.

Aplopappus uniflorus Torr. & Gray, Fl. N. Am. 2: 241. 1842.

This species grows in alkaline meadows, up to an altitude of 2500 m., and ranges from Saskatchewan and Montana to Utah and Colorado.

16. PYRROCOMA HIRTA (A. Gray) Greene, *Erythea*, 2: 69. 1894

Aplopappus hirtus A. Gray, Syn. Fl. 2¹: 127. 1884.

The range of this species includes eastern Oregon, Washington and western Idaho, where it reaches an altitude of 1000 m.

BALSAMORRHIZA Hook.

Leaves entire or bluntly toothed, never pinnatifid.

Plant white-tomentose.

Leaves with entire margins or slightly undulate, oblong-cordate to hastate.

1. *B. sagittata*.

Leaves more or less distinctly toothed, ovate-lanceolate, with subcordate base.

2. *B. tomentosa*.

Plant hirsute puberulent; basal leaves cordate.

Rays linear, deciduous; achenes glabrous.

3. *B. deltoidea*.

Rays oval, becoming papery, and more or less persistent: achenes puberulent.

4. *B. Careyana*.

Leaves mostly pinnatifid or at least incisedly toothed.

Plant canescent or white-tomentose.

Plants loosely white-tomentose.

Stem 1-3 dm. high ; segments of the leaves 1-3 cm. long, ovate, entire or slightly toothed. 5. *B. incana*.

Stem 3 dm. or more high ; segments of the leaves 3-5 cm. long, lanceolate, coarsely toothed. 6. *B. floccosa*.

Plant finely canescent, tomentose only on the involucre ; some of the leaves merely toothed. 7. *B. terebinthacea*.

Plants more or less hispid, neither canescent nor tomentose.

Disk 3-4 cm. broad ; segments of the leaves mostly entire.

8. *B. macrophylla*.

Disk 2-2.5 cm. broad ; segments of the leaves mostly toothed.

9. *B. hirsuta*.

I. BALSAMORRHIZA SAGITTATA (Pursh) Nutt. Trans. Phil. Soc. II.

7: 350. 1840

Bupthalmium sagittatum Fl. Am. Sept. 564. 1814.

Growing on hillsides at an altitude of 1000-2500 m., this species is not uncommon from Alberta and British Columbia to California, Colorado and the Black Hills of South Dakota.

2. *Balsamorhiza tomentosa* sp. nov.

A white-tomentose perennial with thick root ; but the tomentum is shorter and finer than in *B. sagittata*. Basal leaves with long petioles ; blades about 12 dm. long, ovate-lanceolate with subcordate bases, 15-20 cm. long, acute, coarsely toothed ; stem-leaves generally two, including the slender petioles about 1 dm. long, lanceolate to linear elliptic, acute at both ends : stem 3-4 dm. high, involucre densely floccose, over 2 cm. broad : outer bracts half longer than the inner, reflexed : rays about 3 cm. long and 1 cm. wide ; achenes glabrous.

Closely related to *B. sagittata* this species differs mainly in the toothed leaves, shorter tomentum and longer outer bracts.

WYOMING : Headwaters of Tongue River in the Big Horn Mountains, 1898, *F. Tweedy*, 10.*

3. BALSAMORRHIZA DELTOIDEA Nutt. Trans. Am. Phil. Soc. II.

7: 351. 1840

The name of this plant is rather unfortunate, as the leaves are rarely deltoid, but on the contrary usually broadly cordate. *B. deltoidea* ranges from British Columbia to California and Idaho.

* A specimen collected by Tweedy on Teepee Creek in 1899 (no. 2114), may also belong here. It has smaller heads, not reflexed bracts and lanceolate leaves.

4. *BALSAMORRHIZA CAREYANA* A. Gray, Pl. Fendl. 81. 1849

This species grows on sandy plains of Idaho and Washington.

5. *BALSAMORRHIZA INCANA* Nutt. Trans. Am. Phil. Soc. II. 7: 350. 1840

Balsamorrhiza Hookeri var. *incana* A. Gray, Syn. Fl. 2¹: 266. 1884.

This species grows on dry stony hills, up to an altitude of 2500 m., from Montana and Washington to California and Wyoming.

6. *Balsamorrhiza floccosa* sp. nov.

Balsamorrhiza Balsamorrhiza Rydb. Mem. N. Y. Bot. Garden, 1: 417. 1900. Not *Heliopsis Balsamorrhiza* Hook.

A loosely white or gray-tomentose perennial with very thick tap-root. Leaves mostly basal, floccose on both sides, 2-3 dm. long, regularly pinnately divided to near the midrib: some sometimes only coarsely toothed: segments lanceolate, acute, 3-5 cm. long coarsely toothed: stem-leaves 2, near the base, similar but smaller, about 1 dm. long: stem scapiform, 3-5 dm. high, villous or the upper portion densely floccose: involucre about 3 cm. broad, densely floccose; bracts numerous in several series, lanceolate; the outer often spreading with recurved tips; rays 3-4 cm. long, about 1 cm. wide; achenes glabrous, cuneate oblong, with truncate apex.

This species has been mistaken for *B. Balsamorrhiza* (Hook.) Heller or *B. Hookeri* Nutt., but the latter has much finer dissected leaves and its pubescence is quite different. The latter is very short and appressed, never consisting of long villous hairs, and there is never dense wool at the base of the head as in this species. *B. Balsamorrhiza* ranges from Washington to California; but is evidently not found in the Rocky Mountain region. All that I have seen from the region and referred to *B. Balsamorrhiza* by Heller, Holzinger and myself belong to *B. floccosa*. Those collected by Parry, and if I am not mistaken, named by Gray, belong to *B. incana*.

B. floccosa grows on hillsides at an altitude of 1000-2500 m. The following specimens are in the New York herbaria:

MONTANA: Spanish Basin, Gallatin Co., 1897, *Rydberg & Bessey*, 5175 (type).

IDAHO: Lake Waha, 1896, *A. A. & E. Gertrude Heller*, 3298;

Craig Mountain near Lake Waha, 1892, *Sandberg, MacDougal & Heller*, 248.

WYOMING: Headwaters of Tongue River, Big Horn Mountains, 1898, *F. Tweedy*, 11.

7. BALSAMORRHIZA TEREBINTHACEA (Hook.) Nutt. Trans. Am. Phil. Soc. II. 7: 349. 1840

Heliopsis? *terebinthacea* Hook. Fl. Bor. Am. 1: 310. 1833.

In this species, as well as in the next, it often occurs that some of the leaves are not pinnatifid, but merely coarsely dentate. It is a rare plant growing in stony soil in eastern Oregon and western Idaho.

8. BALSAMORRHIZA MACROPHYLLA Nutt. Trans. Am. Phil. Soc. II. 7: 350. 1840

This grows on rocky hillsides in Wyoming, Utah and Idaho.

9. BALSAMORRHIZA HIRSUTA Nutt. Trans. Am. Phil. Soc. II. 7: 349. 1840

This species is found at an altitude of 1000–2000 m, in the dry regions of Utah to British Columbia and California.

THELESPERMA Less.

Heads radiate.

Leaf-segments linear-filiform, 1 mm. or less wide.

Annual or biennial; outer bracts subulate-linear, more than half as long as the inner. 1. *T. trifidum*.

Perennial from a rootstock: outer bracts linear-lanceolate, half as long as the inner or less. 2. *T. tenue*.

Leaf-segments linear, over 1 mm. wide; plant perennial or the first only biennial.

Plant with tap-root, leafy throughout. 3. *T. intermedium*.

Plant with creeping rootstock or woody caudex; leafy only near the base.

Involucre not cleft below the middle; throat of the disk-flowers campanulate, shorter than the lobes. 4. *T. ambiguum*.

Involucre cleft below the middle; throat of the disk-flowers cylindrical, longer than the lobes. 5. *T. subnudum*.

Heads discoid; perennials with rootstock or woody caudex.

Plant less than 2 dm. high; involucre with very broad scarious margins.

6. *T. marginatum*.

Plants 3–6 dm. high; involucre with very narrow scarious margins.

7. *T. gracile*.

1. *THELESPERMA TRIFIDUM* (Poir.) Britton, Trans. N. Y. Acad. Sci. **9**: 182. 1890

Coreopsis trifida Poir. Suppl. Lam. Encycl. **2**: 353. 1811.

- Thelesperma filifolium* A. Gray, Kew Journ. Bot. **1**: 253. 1849.

This species grows in dry soil from Nebraska to Texas and eastern Colorado.

2. *Thelesperma tenue* sp. nov.

A slender, glabrous plant with perennial rootstock. Stems 1-3, slender, less than 2 mm. in diameter, light green, mostly simple and leafy to near the top, 1.5-4 dm. high: leaves twice pinnately dissected into linear filiform segments, mostly appressed to the stem: peduncles 1-3, 5-10 cm. long: outer bracts 6-8, linear-lanceolate, half as long as the inner or less; the inner united to the middle, broadly scarious-margined: rays 8-12 mm. long, 4-6 mm. wide: awns of the pappus very short, about half as long as the width of the summit of the dark shining achenes.

This species resembles most the preceding but has a simpler stem and perennial rootstock. It grows in sandy soil at an altitude of about 2800 m.

COLORADO: Veta Pass, 1900, *Rydberg & Vreeland*, 5473 (type); 1870, *Dr. G. W. Hulse*; Plains, 1871, *Wm. M. Canby*.

3. *Thelesperma intermedium* sp. nov.

A glabrous bushy plant with a biennial or perhaps perennial tap-root. Stems several, much branched and very leafy, 2-6 dm. high: leaves once or twice pinnately divided into linear segments, 1-3 mm. wide: peduncles very numerous, 1-1.5 dm. long: involucre about 1 cm. broad: outer bracts very narrowly linear-lanceolate, about half as long as the inner; these united to about the middle, scarious-margined: rays 10-12 mm. long, 6-8 mm. wide, rounded, 3-toothed at the apex: teeth of the pappus longer than the width of the achenes.

This has been confused with *T. ambiguum*, but is of a quite different habit. *T. intermedium* is much branched and very leafy throughout, has a vertical tap-root of short duration, numerous heads, rather long outer bracts and the inner with narrow scarious margins. *T. ambiguum* is leafy only at the base, has a creeping rootstock, very short outer bracts and the inner with a very broad scarious margin.

T. intermedium grows in sandy or loose soil, often taking possession of old fields and acts much like a weed. The following specimens are at hand.

NEBRASKA: Banner County, 1890, *Rydb. 192* (type); Crawford, 1889, *H. J. Webber*.

WYOMING: Pine Bluffs, 1897, *Aven Nelson, 3503*.

COLORADO: 1862, *Hall & Harbour, 280*, at least in part.

COLORADO or WYOMING: 1843, *Fremont*.

NEW MEXICO: Between Santa Fe and Canoncito, 1897, *A. A. & E. Gertrude Heller, 3747*.

4. THELESERMA AMBIGUUM A. Gray, Proc. Am. Acad. **19**: 16.
1883

This species seems to be confined to the plains of western Texas, New Mexico and southern Colorado. The specimens reported from Nebraska and Wyoming belong mostly to the preceding, and those from Montana to *T. marginatum*. The latter resembles *T. ambiguum* in many respects, especially as to the involucre bracts; but it is always without ray-flowers.

5. THELESERMA SUBNUDUM A. Gray, Proc. Am. Acad. **10**: 72.
1874

This is an inhabitant of the more arid regions of New Mexico, Arizona, Utah and Colorado.

6. THELESERMA MARGINATUM Rydb. Mem. N. Y. Bot. Garden, **1**:
421. 1900

This grows on dry plains of Alberta and Montana.

7. THELESERMA GRACILE (Torr.) A. Gray, Kew Journ. Bot. **1**:
253. 1849

Bidens gracilis Torr. Ann. Lyc. N. Y. **2**: 215. 1827.

This species is the most common and most widely distributed species of the genus. It is common on dry plains from Nebraska to Montana, Arizona, Mexico and Texas.

HYMENOPAPPUS L'Her.

Throat of the corolla 1-1.5 mm. long, not over twice as long as the lobes.

Pappus over 1 mm. long, equaling the corolla-tube or nearly so.

Stem 3-6 dm. high, leafy throughout; heads numerous.

Plant sparingly and loosely floccose; leaves glabrate in age.

1. *H. tenuifolius*.

Plant densely tomentose; leaves permanently tomentose.

2. *H. tomentosus*.

Stem less than 3 dm. high.

Stem-leaves much reduced; stem white-tomentose or nearly so; heads few.

3. *H. scaposus*.

Stem-leaves not much reduced; stem sparingly grayish tomentose.

5. *H. cinereus*.

Pappus 1 mm. or less long, shorter than the corolla-tube; stem-leaves and heads few.

Pappus not hidden by the hairs of the achenes.

Stem permanently densely white-tomentose; achenes silky.

4. *H. arenosus*.

Stem sparingly grayish tomentose, glabrate in age; achenes loosely villous

5. *H. cinereus*.

Pappus hidden by the hairs of the achenes, or sometimes none.

Leaflets glabrate in age, at least above; ultimate segment 5-30 mm. long.

6. *H. filifolius*.

Leaves permanently densely white-tomentose; ultimate segments short, 1-5 mm. long.

7. *H. luteus*.

Throat of the corolla 3-4 mm. long, 3-4 times as long as the lobes. 8. *H. macroglottis*.

1. HYMENOPAPPUS TENUIFOLIUS Pursh, Fl. Am. Sept. 742. 1814

This is generally described as a biennial; occasionally the root is of a longer duration and the plant becomes a short-lived perennial and then hard to distinguish from a large specimen of *H. filifolius* except by the pappus. *H. tenuifolius* grows on prairies, from Nebraska and Wyoming to Texas.

2. *Hymenopappus tomentosus* sp. nov.

A densely and permanently white-tomentose plant, apparently biennial. Stem 3-4 dm. high, leafy and branched above: leaves 5-7 cm. long, bi-pinnately divided into linear segments, 4-10 mm. long, about 1 mm. wide: heads many, corymbose-paniculate, about 8 mm. high and broad; involucre densely woolly, somewhat turbinate: flowers yellow: corolla tube and throat each a little over 1 mm. long; the latter broadly campanulate, of about the same length as the lobes; achenes silky strigose; scales of the pappus a little shorter than the corolla-tube.

Nearest related to the preceding, this species is easily distinguished by the dense permanent tomentum and the yellow flowers.

UTAH: St. George, 1877, Dr. E. Palmer, 270 (type in the Columbia Herbarium).

3. **Hymenopappus scaposus** sp. nov.

Hymenopappus luteus A. Gray, Pl. Fendl. 97. 1849. Not Nutt. 1841.

An almost scapose perennial with a caespitose caudex. Stem almost naked, with 1-2 reduced leaves, more or less densely tomentose: leaves mostly basal, 5-7 cm. long, bipinnately divided into linear segments, 3-10 mm. long, more or less densely tomentose, especially at the base: heads few, corymbose, hemispherical, about 1 cm. high and broad: bracts obovate with yellowish or purplish scarious margins: corollas yellow; tube and throat each nearly 2 mm. long; the latter campanulate and longer than the lobes: achenes densely silky, scales of the pappus fully 2 mm. long, longer than the tube of the corolla.

This species has been confused with *H. luteus* Nutt. but is easily distinguished by the long pappus and also by the longer segments of the leaves. *H. scaposus* grows in dry soil up to an altitude of 2200 m. from New Mexico and Arizona to Utah and Nevada.

ARIZONA: Vicinity of Flagstaff, 1898, *D. T. MacDougal*, 129 (type).

NEW MEXICO: Santa Fee, 1897, *A. A. & E. Gertrude Heller*, 3555; 1847, *A. Fendler*, 456; 1869, *E. Palmer*, 11.

UTAH: Southern Utah, 1874, *C. C. Parry*, 107.

NEVADA: 1868, *S. Watson*, 612.

4. **HYMENOPAPPUS ARENOSUS** Heller, Bull. Torr. Club, 25: 200. 1898

This resembles somewhat the preceding, but is taller, more leafy, and has much shorter pappus. It grows in sandy soil, up to an altitude of 2200 m., in New Mexico and southern Colorado.

5. **Hymenopappus cinereus** sp. nov.

A grayish tomentose perennial with a caespitose caudex. Stems about 2 dm. high, branched, with 2-4 leaves: these bi-pinnately divided into linear segments 1-2 cm. long and about 1 mm. wide, sparingly grayish tomentulose: heads corymbose, 8-10 mm. high, 10-12 mm. broad, hemispherical or somewhat turbinate: bracts oblong-obovate, with narrow scarious margins: corollas yellow: tube and throat each about 1.5 mm. long; the latter broadly campanulate, longer than the lobes: achenes loosely villous; scales of the pappus variable, in the type fully 1 mm. long and nearly equal-

ing the corolla-tube, but often shorter, yet never hidden by the hairs of the achenes.

This species has been confused with *H. filifolius* and *H. flavescens*. Baker, Earle & Tracy's specimens were determined as the latter by Professor Greene. The species is, however, much nearer related to *H. filifolius*, from which it differs mainly in the lower habit and the longer scales of the pappus. These characters, together with the longer lobes of the leaves distinguish it from *H. luteus*. It grows on dry hills, at an altitude of 1500-3000 m.

COLORADO: Walsenburg, 1900, *Rydberg & Ireland*, 5479 (type); Mesas near Pueblo, 5477; Cuchara Valley, 5478; Durango, 1898, *Baker, Earle & Tracy*, 1028; Garden of the Gods, near Pikes Peak, 1895, *E. A. Bessey*.

6. HYMENOPAPPUS FILIFOLIUS Hook. Fl. Bor. Am. 1: 317. 1833

This species is common on plains and prairies to an altitude of 2000 m., and ranges from Saskatchewan and Montana to Colorado and Nebraska.

7. HYMENOPAPPUS LUTEUS Nutt. Trans. Am. Phil. Soc. (II.) 7: 374. 1841

Dr. Gray in his Synoptical Flora referred this species to *H. filifolius*, which, however, does not fit Nuttall's description. Many years before he had named Fendler's specimens *H. luteus*. These agree fairly well with Nuttall's description, except as to the pappus, which in them is much more prominent than in any of the other species. Nuttall states that the scales of the pappus of *H. luteus* are very short and hidden by the hairs of the achenes.

In 1897 Prof. Aven Nelson collected a *Hymenopappus* on Green River, which he intended to describe as new, especially as the type specimen was without pappus. A closer examination revealed, however, that some of the specimens really had some small scales. These agreed perfectly with Nuttall's description. Nelson's specimens and my own, collected two years before, also on Green River, are the only ones that perfectly agree with Nuttall's description of *H. luteus*. His type was collected on the Ham's Fork of the Colorado of the West. What the present name of Ham's Fork is or its exact location I have been unable

to find ; but from the route that Nuttall took it is undoubtedly some stream of the Green River system.

8. *Hymenopappus macroglottis* sp. nov.

Slightly tomentose perennial with a woody caudex. Stems several, 3-4 dm. high, striate, slightly floccose when young, with 1-3 leaves : leaves mostly basal, about 1 dm. long, bi-pinnately divided into linear lobes 8-25 mm. long, 1-2 mm. wide ; stem-leaves generally simply pinnate or the uppermost simple : heads few, corymbose, 12 mm. high and 12-15 mm. broad, hemispherical : bracts oblong, with very narrow yellowish scarious margins : corolla yellow ; tube about 2 mm. long ; throat deeply campanulate, 3-4 mm. long, 3-4 times as long as the lobes : achenes elongated obpyramidal, about 5 mm. long, hirsute : scales of the pappus about 1 mm. long.

The long and broad lobes of the leaves and the long throat of the corolla distinguishes it from other species of the Rocky Mountains. The latter character it has common with only *H. lugens* Greene from southern California. This has, however, much more finely dissected leaves. *H. macroglottis* grows in arid regions from Texas to Arizona and north to Colorado or Utah.

ARIZONA : Oak Creek, 1883, *H. H. Rusby* (type).

NEW MEXICO : 1851-52, *Wright*, 1252.

TEXAS : Camp 42, 1853, *Bigelow*, 730.

COLORADO or UTAH : 1843, *Fremont*.



CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 11.

LIFE HISTORY OF SCHIZAEA PUSILLA

By ELIZABETH G. BRITTON AND ALEXANDRINA TAYLOR

NEW YORK
1901

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Life History of *Schizaea pusilla*

BY ELIZABETH G. BRITTON AND ALEXANDRINA TAYLOR

(WITH PLATES I-6)

The material on which these studies were based was collected at Forked River, New Jersey, on the third of July, 1900. The plants were abundant, but only half grown, the sporophylls being only five centimeters high. They were found around the base of small white cedars (*Chamaecyparis thyoides*) kept moist by hummocks of *Sphagnum*, and surrounded by *Lycopodium Carolinianum*, *Juncus pelocarpus*, *Drosera rotundifolia* and *Utricularia cleistogama*. Young plants were found, ranging from two to ten millimeters in height, growing in depressions of moist sandy loam, or even perched upon the roots of sedges and *Sisyrinchium Atlanticum*. Several sods were taken with the plants in various stages, and a large number of young plants were collected and preserved in alcohol. With a magnification of fifteen diameters, it was discovered at the time of collection that they originated from a filamentous protonema, consisting of a tangled mass of dark green filaments, spreading around the base of the young circinate leaf, and that these filaments were persistent, even after some of the leaves were 10-15 mm. high. Entangled with the filaments, in such a manner as to render it necessary to clean them with a camel's-hair brush, there were three species of hepatics (*Odontoschisma sphagni* (Dicks.) Dumort; *Lophozia inflata* (Huds.) M. A. Howe; and *Cephalozia catenulata* (Hübner.) Spruce; also a slender fresh-water alga, *Rhizoclonium hieroglyphicum* (Ag.) Kütz.

A complete or correct description of *S. pusilla* cannot be found in any manual or monograph. In several the spores are said to be smooth, and the glandular hairs borne by the leaves are not mentioned, though they are known on other species of this genus.

The gametophyte is composed of numerous, erect, branching, dark green protonemal filaments; monoicous, bearing from 5-12 archegonia, usually on a slightly thickened and expanded series of cells in the nature of an archegoniophore (?) or directly on the filaments; antheridia more numerous, often on separate branches and nearer the extremities of the filaments; radicles seldom borne on the filament but produced from specially modified, large spherical cells, apparently in symbiotic relation with a fungus. Sporophyte perennial, from a short erect or horizontal rootstock, 5-10 mm. long, sterile leaf 2-5 cm. long by 0.5 mm. broad, circinate, bearing small club-shaped hairs, nearly 1 mm. long, occurring in three longitudinal rows on the dorsal surface, alternating with two rows of stomata. Sporophyll 3-13 cm. long, divided at summit into 14-16 fertile pinnae; sporangia ovoid, with a terminal ring: spores reniform, pitted, 76-84 μ , maturing in autumn.

On low wet banks with sphagna or in sandy swamps, in the shade of larger plants; known from numerous scattered stations in the Pine Barrens of New Jersey, in Newfoundland (De La Pylaie, Waghorne), and in Nova Scotia (E. G. Knight). The station credited to New York by Prantl from the Berlin Herbarium, is probably a mistake, though there is no reason why it should not be found on the sandy plains of Long Island and Rhode Island.

According to Prantl there are nineteen species of *Schizaea*, of which five are Polynesian, eight are found in Brazil, and five in the West Indies; all are of restricted distribution, and in most species they are known from few stations. Of *Lygodium* he records twenty-two species, of which five are Mexican and Central American, four West Indian and only one from northeastern North America, *L. palmatum*. Of the forty-six species of *Ornithopteris* and *Anemia* known, Brazil has thirty-five, Mexico nine, the West Indies six and only two extend into the United States, *O. adiantifolia* (L.) Bernh., and *O. Mexicana* (Kl.) Underw.

The Schizaeaceae are represented in the Tertiary by several

species of *Lygodium*, and by *Anemia* in the Cretaceous. Thus far *Schizaea* is unknown in the fossil state. We may safely conclude, however, that its maximum development in North America must have been reached previous to the Glacial period, and that it is in a degenerate condition and retrograding distribution in the only surviving species, *Schizaea pusilla*, whose larger and more highly developed relatives exist now only in the tropics.

SPORES

The spores of *Schizaea pusilla* measure 76–84 μ , are nearly reniform (Fig. 1), and have a cuticularized exospore which is alveolate (Figs. 2, 3); on the concave side there is a ridge extending nearly two thirds the length of the spore, formed by the exospore having a fissure nearly its whole length (Fig. 4). It is through this slit in the exospore that the young tube emerges when the spore germinates.

The development of the gametophyte from the spore to the first archegonium could not be followed in the laboratory; but from the laboratory cultures and the different stages of spore germination found in the soil brought up from New Jersey a fairly good idea of the manner and rate of growth may be drawn.

Spores, from the plants collected in July and matured in the greenhouse, were sown on September 5th; on the 14th they were found to be slightly green; the first signs of germination were seen on the 27th, when the spores contained some chlorophyll, and two had started to send out a tube which extended 27 μ beyond the aperture (Fig. 5); chlorophyll was visible in the lengthening tube on the 8th and rhizoids were also found on that date; the first cross-wall was formed on the 10th; on October 1st the second wall was formed making a filament of two cells (Figs. 9, 10).

On August 28th a spore was found in the sod of young plants which had germinated and formed a small rhizoid, slightly brown, with a curved apex and contained some chlorophyll, and a filament, 115 μ in length, of two cells (Fig. 19), the cell at base was shorter, about twice as long as broad, containing chlorophyll with no special arrangement; the other cell was nearly four times as long as broad, the chlorophyll denser at the apex and a newly formed wall (Fig. 19, a). The density of the chlorophyll increased at the

apex. On August 30th the chlorophyl showed a tendency to assume its final arrangement in the filament, being very dense in the center, radiating toward the walls in rather thick bands and connecting with a layer next to the wall through the whole length of the cell; on August 31st the filament had lengthened to $126\ \mu$ and one more cell had been cut off (Fig. 21), no further change in the rhizoid having taken place. The filament consisted of five cells by September 2d. On September 4th the filament had increased to six cells, and a partial division of the contents of the apical cell had taken place (Fig. 22). The tip of the filament was very much curved and densely packed with chlorophyl; the basal cell of the filament had become slightly swollen near its apical end. The filament measured $146\ \mu$.

On September 5th the filament consisted of six cells (Fig. 23); the first walls formed were very nearly as thick as the cross-walls of the older filaments.

The older filaments generally grow erect, and this tendency toward an upward growth is plainly shown even as early as the third cell of the filament; the rhizoid also showed geotropic curvature. One tube, issuing from the fissure of an exospore, was directed downward; but soon began a curvature which was continued until the filament occupied a vertical position; the rhizoid, first directed horizontally, soon curved downward. The filaments, for the most part, did not show the tendency to upward growth until two or three cells had been formed, but the rhizoid took a downward direction much earlier.

On September 5th another spore was found in the soil consisting of one filament of six cells (Fig. 24); at the base of the filament, at its connection with the spore, there was a cell which had evidently been the basal cell of another filament. The remaining filament had given rise to two antheridia, which though not dried up were empty; one antheridium arose from a short branch from the second cell, occupying the terminal cell of the branch; the other originated from the terminal cell of the filament.

A spore with a healthy filament of four cells (Fig. 26) had borne an antheridium in which the mother cells of the antherozoids could be easily seen.

The attachment of the spore appears to be of long duration, as antheridia are formed while the filament is still attached.

A sporangium (Fig. 27) filled with spores was sown at the same time with the free spores on September 5th, and a great number of the spores germinated inside the sporangium sending out filaments through a basal break; when the spores were removed from the sporangium they were found to be more advanced than those germinating outside, the rate of growth of the spores in the sporangium in a given time being almost twice that of the other spores.

Branches were given off from the basal cells of the filaments, sometimes from apical portions of young filaments, and in a few cases the spore cell was found to divide into three primary cells (Fig. 17).

Intermediate stages between the earliest developed filament from the spore and the much-branched protonema are lacking.

PROTONEMA

The protonema occurs on the substratum, or on rootstocks of other plants, as small tufts of a dark green color, growing to a height of 2 mm. and a breadth of 4 mm.

The protonemal filaments are larger than the protonema of mosses. A comparison was made with *Pogonatum brevicaule* and *Mnium punctatum* with the following results:

	Length	Breadth
Cells of <i>Pogonatum brevicaule</i>	$\left\{ \begin{array}{l} 46 \mu \\ 76.9 \mu \end{array} \right.$	7 μ
Cells of <i>Mnium punctatum</i>	$\left\{ \begin{array}{l} 115 \mu \\ 96 \mu \end{array} \right.$	$\begin{array}{l} 15 \mu \\ 23 \mu \end{array}$
Cells of <i>Schizaea pusilla</i>	$\left\{ \begin{array}{l} 192 \mu \\ 173 \mu \\ 134 \mu \end{array} \right.$	$\begin{array}{l} 92 \mu \\ 38 \mu \end{array}$

It is also seen from the above that the cells of the filaments of *Schizaea pusilla* are fairly uniform in dimensions. They are densely filled with chlorophyl; starch is present. The cells are cylindrical, sometimes flattened near the base, in the region of the archegonia. Some few of the cross-walls were found to be perforated.

The protonema is copiously branched, the branches being generally single from each of the cells of the filament, generally near the upper end of the cell (Figs. 72, 73). Occasionally three or four in succession will give rise to two branches from opposite

sides, but maintain the same relative position (Fig. 30). The branches, which give rise to the spherical cells to be described below, divide in the same manner as the main filaments. The division of other branches is very irregular (Figs. 29, 30, 31). The rhizoids are not usually formed directly from the ordinary cells, but from specially modified cells (Fig. 38, *a*); in three instances only were rhizoids found directly on the filaments, and in one case one cell gave rise to two rhizoids. They arise as lateral branches, at right angles to the long axis of the filament and taking the place of branches (Figs. 38, 39). There were two cases found (Figs. 32, 33) where the cells of a branch, near the apex, had formed partition walls. In Fig. 32 the third cell from the apex had divided up into four cells, showing a tendency to form a flat prothallus. Three cells showed signs of division (Fig. 33): these two instances were the only ones found. Bower speaks of flattened expansions on the filamentous protonema of *Trichomanes alatum* and *Trichomanes sinuosum* as described by Mettenius. These are much more rudimentary in *Schizaea pusilla*.

Some cells of the filament have been found to undergo division in the later stages, into a number of disk-shaped cells which do not increase in the axial diameter. Constrictions sometimes follow such divisions at the older cross walls; the cell walls were a light brown and showed signs of decay. Fig. 35 shows the cells of the filament undergoing the same process, but these were as healthy as the rest of the filament and densely filled with chlorophyll. Bower refers (Ann. Bot. 1: *pl. I. f. 8*) to a similar development in *Trichomanes pyxidiferum* and says that " * * * possibly the moniliform development is merely a pathological condition; its appearance, however, is suggestive of that segmentation of the protonema into spherical cells which is recorded as a mode of vegetative propagation for the protonema of *Funaria hygrometrica*."

After some of the filaments have formed several cells the apical cell cuts off a new cell, which, after the first partition wall, that is transverse septum, divides longitudinally, forming two cells (Figs. 36, 37). These cells become large and round, each cell containing chlorophyll, and giving rise to one, or generally two, rhizoids (Fig. 37, *a*). The rhizoids also contain chlorophyll and early take on a dark yellow color. The original cell of the fila-

ment from which these cells arise either continues its growth normally (Fig. 36), or by a lateral innovation (Fig. 37). This new filament, after the formation of two or three cells, may form spherical cells at its apex (Fig. 39), or continue for some time before doing so, or it may send off a branch at once, which in its turn forms spherical cells. Generally a filament forming the spherical cells once does so at intervals throughout its whole length (Figs. 72, 73). These branches early bend to the substratum. If examined at this stage they will be found to have lost their former contents and to be filled with fungal hyphae (Fig. 43). This fungus does not injure its host, but sets up a symbiotic connection by which it functions as an absorbing organ to supply the gametophyte. So the spherical cells are undoubtedly formed by the gametophyte for the reception of the fungus, which enters as soon as the rhizoids touch the substratum (Fig. 41). While above ground and filled with chlorophyll they do not show any evidence of the presence of a fungus. The rhizoids wither early and absorption is carried on almost entirely by the fungal hyphae. The lack of rhizoids on the filament is thus explained by the presence of this fungus symbiont. The rhizoids formed from these spherical bodies appear to be the only channels through which the fungus enters the chambers built for it.

As to the nature of the fungus it is at present impossible to give it a permanent place in any of the series because of lack of evidence in regard to its method of reproduction. Perithecia have been found with asci and also what was probably a conidial stage; fruit bodies of other forms have also been found among the filaments; however, none of these were connected with the fungal hyphae under discussion. The young filament shortly after germination was in some few cases attacked by a fungus (Fig. 17, *d*), and this fungus is found wrapped around many of the cells of the older filaments, several instances having been found where haustoria had penetrated into the cells. Some of the plants are so infected by fungi after the growth of the sporophyte has begun that all the filaments have thickened walls and are pierced by three or four haustoria in each cell; they have turned brown and lost their contents. This fungus not only clings to the gametophyte of *Schizaea pusilla* but attacks the sporophyte also, though it does

not appear on the sporophyte until the first leaf has reached a height of 1 mm. It resembles the one referred to by Bower in his work on *Trichomanes*. No connection has yet been made between these hyphae and those of the fungus symbiont. As far as is known at present, the fungus which wraps itself around the protonemal filaments is the same or at least bears a very close resemblance to that which attacks the sporophyte both on the rhizome and leaf.

The hyphae of the symbiotic fungus penetrates the rhizoid generally a short distance back from the tip (Fig. 41, c). These hyphae sometimes branch in the rhizoid and their cross-walls are more numerous, and in many cases the hyphal threads appeared narrower. They enter the large spherical cells where they form bladders or granulated swellings in these cells, sometimes nearly filling them (Figs. 42, 43). The fungus sometimes penetrates the ordinary cells of the filament, entirely changing the shape of these cells. Pale brown bodies were found of irregular outline attached to the hyphae which were apparently sporangia.

ANTHERIDIA

The antheridia are produced laterally on the protonema, occupying the terminal cell of the lateral branch or more rarely the terminal cell of a filament, which continues its growth laterally or ends with the formation of the antheridium. They are found either singly or in groups; and may be considered as metamorphosed branches as in Fig. 44. They may either be formed from the terminal cell of a short lateral branch (Fig. 44) or from the terminal cell of a branch given off from the basal cell (Figs. 44, 48) or from the second or any other cell of a lateral branch (Fig. 44) or rarely they may be formed on the terminal cell of a short lateral branch given off from the same cell of the filament as a previous antheridial branch (Fig. 46). Occasionally these groups are borne on a branch of the filament which bears only antheridia (Fig. 48) and for the most part in groups, sometimes from both sides of a branch. These branches which bear the antheridia, whether it is a branch of two cells with the apical one becoming an antheridium, or one of the groups, occupies the same relative position on the filament as do the branches of the main filament.

One or two were found to start out from the center of a cell of a filament. The antheridia are produced in great quantities but a great number of them are aborted, and the majority of antheridia terminate a branch of two cells. They occur nearer the apex of the filaments than the archegonia, and sometimes on the same filament with the archegonia (Fig. 57). They also occur on a branch from the filament which gives rise to the archegonia; when they are borne on a separate filament they are generally formed in larger quantities. The cells of a filament which give rise to the antheridial clusters are often broader and sometimes shorter than the ordinary cells.

The antheridium is formed by a cell of a filament sending out a cell which divides by a partition wall near the apex (Figs. 49, 50). This apical cell enlarges and soon cuts off another cell by a wall parallel with the first (Fig. 51). This small cell does not elongate but always remains short and forms the pedestal for the antheridium; the apical cell becomes large and globular and cuts off a cap cell at the summit, with the wall oblique (Fig. 52); the large cell divides up into the mother cells of the antherozoids (Figs. 52, 53, 54) and one ring cell. In some cases there appear to be a single layer of two or three peripheral cells. The ring cell (or cells) contain chlorophyl though they lose this before the antherozoids are matured. Dehiscence takes place by the swelling of the ring cell and the rupture of the cap cell. The antherozoids appear to be surrounded by a very fine membrane when they escape from the antheridium (Fig. 55); they are spirally coiled, with cilia at their anterior ends. Very few ripe antheridia were found. The antherozoids do not seem to be produced in large quantities.

ARCHEGONIA

The archegonia occur nearer the base of the filaments than the antheridia (Fig. 57) on cells of the filaments which have become more than one cell wide through division. They generally bear the same relation to the original cell of the filament as do the branches from other cells; they are borne singly or in pairs (Fig. 63), sometimes in groups of three or four (Fig. 58) often on both sides of the protonema. One filament was found which gave rise on six consecutive cells to two archegonia each; two cells above

the sixth cell there was another archegonium formed, and a cell above this another one, and branches also gave rise to archegonia. There is no filament that is specially reserved for the formation of archegonia as is sometimes the case with the antheridia. Each archegonium is derived from a single superficial cell.

The archegonia are formed by the division of the initial cell into three cells; the basal cell forms the venter which may or may not be imbedded in the cell of the filament. Some of the division cells of the original cell of the filament grow up around it in such a way as to make it appear as if imbedded (Fig. 65). From the neck cell arises the neck of the archegonium, consisting of four rows of cells, of four cells each (Figs. 60, 62, 63); a uniformity which produces a straight neck to the archegonium.

Occasionally the cells of the two rows on the posterior side, though they do not increase in number, become larger than those on the anterior side (Fig. 62) thus slightly bending the neck toward the anterior side. From the middle cell of the superficial mother cell arises the central cell and the canal cell; the middle cell becomes sharply pointed on the upper end and forces itself between the neck cells; this point is cut off, forming the canal cell; the larger cell divides again into two cells of unequal size: the smaller and upper one forms the ventral canal cell, the lower and larger one forms the egg cell (Fig. 59). When this is mature the canal cells dissolve into mucilage. When the archegonium opens, the four stigmatic cells, which in this species are very large, are not thrown off but fold back (Fig. 63). It is at this stage that the curve in the neck occurs in some archegonia due possibly to the fact that as the filaments grow erect or nearly so, the archegonia occupy the portion of the filaments below the antheridia, and by bending the neck they bring the canal to the oösphere in a more direct line for the capture of the antherozoids, an adaptation tending to secure fertilization. Generally several archegonia are present, but only one seems to give rise to a sporophyte.

The cushion of cells on which the archegonia are borne can hardly be called an archegoniophore as some of these cells give rise to vegetative branches (Fig. 65). Three cases were found where an archegonium arose directly from a cell of the filament without any partition other than that of the formation of the ar-

chegonium. Bower (*l. c.*, Figs. 11, 12) says in his description of the archegonia of *Trichomanes pyxidiferum*, "The archegonia are borne on massive growths (archegoniophores). * * * In one case, however which has a special interest the mass of tissue on which the archegonia are produced is obviously the result of partition of a single cell of a filament, without any marked increase in size having taken place (Fig. 13). This may be regarded as the simplest form of an archegoniophore hitherto described in any fern or even in any Bryophyte and it approaches near to that suggested by Goebel as the simplest possible, in which the sexual organs would be inserted directly on the protonemal threads."

The act of fertilization was not seen, nor the direction of the first wall, but, from later stages they appear to be formed as is common with most ferns; a wall is formed parallel with the long axis of the archegonium, then a cross-wall is formed.

Foot

The foot is in most cases extremely large, and is in every case a well-defined organ, consisting of a great mass of cells which for the most part contain chlorophyll (Figs. 69, 70, 71). It remains attached to the protonema for some time, having been found in connection with it after the formation of the third leaf (Fig. 75, *a*), and even here it appeared to be in a healthy condition as did also that part of the protonema on which the foot was borne. It grows down into the cushion of the gametophyte (some of the cushion cells appear to grow up around it). The venter cells grow and form a calyptra around the embryo covering it for some little time; remnants of it were found still clinging around the first root after the formation of three leaves (Fig. 75, *b*).

Root

The primary root is a prolongation of the main axis of the sporophyte (Figs. 71, 72, 73), while the ultimate roots are always adventitious and produced in acropetal succession. They arise from all sides of the erect rhizome (Fig. 79), the epidermis of which sends out rhizoids. The primary root is persistent and becomes quite long. The second and third roots have a vestigial structure which covers them as the coleorhiza of some endogens

(Fig. 76). The roots are fully formed and have root caps (Fig. 75, *d*). This root cap (Fig. 76) consists of four large pear-shaped cells, inflated on one side; the inflated side is away from the root, the concave side rests on the root tip. They are developed before the root sheath splits. The cells are replaced from the tip and, as the older ones do not always fall off when the new ones have been formed, there have been seen as many as five series (Fig. 77), though they show their age by the partial discoloration of their walls.

The epidermal cells are large and thin-walled; the outer walls often bend into the cavity of the cell and frequently break. The cortex consists of two layers; the cells of the inner layer are very large and have the walls that lie next to the endodermis thickened; but in no instance was the thickening found to be as great as that figured for *Schizaea Pennula*. There is an endodermis of two layers, and the central cylinder (Fig. 78) is like that described by Prantl (Untersuch. Morph. Gefässkrypt., *pl.* 4) for *Schizaea Pennula*.

Sclerosis takes place in all the layers without any marked increase in the thickness of the walls.

RHIZOME

The rhizome is erect (Fig. 79), occasionally creeping. It always forms a protective covering of trichomes over the growing end (Fig. 74, *d*); these trichomes consist of from two to five cells (Fig. 75, *h*), measuring 1 mm. in length which soon turn brown and are persistent. The internodes are of varying lengths. One rootstock (8 mm.) had borne nineteen sterile and two sporophylls, all dead except the five sterile leaves last formed. The fertile leaves measured 6.5 cm., the longest sterile leaf 4.5 cm. Another rhizome of the same length had twenty-two sterile leaves, six green and two nearly brown, with two fertile; these were 7 cm. high, the base of the fertile leaves was green, the sporangia brown and mature. There were twenty-two roots—six short and young; one root was 25 mm. long and had branched; the branches were 5 mm. long.

A cross-section near the young tip shows a central bundle with a well developed endodermis (Fig. 80). Sclerosis takes place in the entire cortex; the different stages are beautifully shown in

young sections; these cells, including the epidermis, are filled with starch. The epidermis and cortex are often invaded by fungal hyphae.

The vascular bundle is concentric; the xylem portion is enveloped in the phloem. The central cylinder is surrounded by a well-defined endodermis and phloem sheath, the radial walls of which are thin and fragile; the phloem elements are represented by two or three imperfect rows of narrow parenchymatous cells and sieve tubes; the xylem consists of scalariform tracheids with occasionally small spiral tracheids close to the phloem. The medullary parenchyma is composed of large, thick-walled cells, pitted, and early showing sclerosis, but not as early as the fundamental tissue outside the bundle.

STERILE LEAVES

The sterile leaves are linear, slender and tortuous. The development of the leaf is very slow, the lower portions having long been fully formed while the apex is still unfolding. The vernation is circinate (Fig. 79). Owing to the more rapid growth of the cells on the dorsal side than those on the ventral, the leaf is rolled up on the ventral side. When fully developed they bear on their dorsal side two rows of stomata alternating with three rows of glands (Fig. 81), sometimes four or more rows of glands. The glands seem to originate from special cells cut off from the epidermis; these epidermal cells frequently do not lengthen, keeping very nearly an isodiametric shape; when they do lengthen the glands remain at or near the upper wall.

The young leaves and the tip of the stem are more or less completely clothed with trichomes early turning brown. These are not to be confounded with the glandular hairs. They are composed of two or more cells and are extremely long, measuring in some instances 1 mm. to 3 mm. or perhaps more. The longest glands of the leaf measured nearly 100 μ , others 76 μ and in width 31 μ . Some are composed of one cell, others of two cells; they are all club-shaped and contain granular protoplasm. These glands were rarely found on the ventral surface, and sometimes they did not appear to follow any law as to their formation on the dorsal surface, though, for the most part, they were formed in alternate rows with the stomata.

The stomata are restricted to two rows of epidermal cells and almost every epidermal cell in these rows gives rise to one (Fig. 82). A cell of the epidermis before it has lengthened forms a U-shaped wall at the upper end of the cell (Figs. 86, *a*, *b*); the points of the U meet the radial wall which separates this cell from the one next above (Fig. 86, *b*); this cell becomes the mother cell of the stoma, and by growth presses the partition wall back a short distance into the upper epidermal cell (Fig. 86, *c*). This cell divides by a tangential wall into two cells of equal size; these become the guard cells (Fig. 86, *c*, *d*) each containing abundant chlorophyl. These guard cells enlarge considerably (Fig. 86, *d*, *e*) so that they are raised above the epidermis as shown in an oblique view (Fig. 83). The wall between the guard cells splits along its central portion making an opening to the space below; the epidermal cell meanwhile has lengthened and the cell above has formed a stoma in the same way. The leaf bundle is more nearly collateral than that of the stem; the xylem faces the ventral, the phloem the dorsal surface of the leaf (Figs. 88, 90). There is a two-rowed endodermis around the bundle; the epidermal cells are large and in some instances occupy one half of the cross section. The ground tissue is made up of thin-walled parenchyma with numerous air spaces (Fig. 89) and the cells contain chlorophyl.

SPOROPHYLL

The sporophyll is very similar to the sterile leaf with the exception of the formation at its apex of pinnae bearing the sporangia; these have been carefully studied by Prantl and others in several species of *Schizaea*, the descriptions of which, from present observations, appear to hold good for *Schizaea pusilla*. One of the largest sporophylls measured 13 cm. from base to apex, the portion bearing the pinnae was 6 mm. long and eight pinnae were formed on one side and seven on the other; the longest pinna measured 4 mm., of this $2\frac{2}{3}$ mm. is the portion which bore the sporangia. The lowest pinna on each side had formed four sporangia each, the others eight each. Prantl figures six sporangia for *Schizaea dichotoma*, and sixteen for *Schizaea Pennula*. The edge of each pinna rolls up over the sporangia, forming an indusium, and the end cells at the summit and also along the mar-

gin produce trichomes which also cover the sporangia. These trichomes are often composed of more than one cell, and resemble the trichomes formed by the rhizome and are in some instances as long as 134 μ , 345 μ , 461 μ , the width being 38 μ , and 30 μ .

A surface view of the dorsal side of the sporophyll shows two rows of stomata alternating in some cases with rows of glands, though these sometimes are not in rows, and occasionally only two glands were found. These glands are smaller than those generally found on the sterile leaf measuring only 38 μ .

The stomata appear sunk below the epidermis, but a cross-section showed them to be the same as in the sterile leaf. The two rows of stomata continue up the leaf from the base to the pinnae, where they are lost in a great number of stomata which cover the dorsal surface of the pinnae with no special arrangement. No glands were found on any of the pinnae examined.

The warts or swellings from the epidermal cells are far more numerous in the sporophyll, though they are found on the sterile leaf (Fig. 93, *a*). They do not appear to follow any law as to their arrangement on either leaf, though they appeared to be more numerous on the ventral side. The epidermal walls are thicker than the epidermal walls of the sterile leaf, some of which had extremely thin walls and a rudimentary bundle (Fig. 90).

The bundle has a well-marked endodermis ; it appeared from the cross-section to be collateral as did all the bundles with the exception of that of the rhizome (Fig. 94). The elements of the bundle were not traced out, but reticulated and ring tracheids were found in the xylem. The mesophyll tissue of the sporophyll (Fig. 89) is composed of thin-walled cells with numerous air spaces : these cells seem to be branched in a stellate manner in both sterile leaves and sporophylls.

SUMMARY

The spores are small, are nearly reniform, and have a cuticularized exospore which is alveolate. There is a ridge along the concave side having a fissure nearly its whole length through which the young tube emerges when the spore germinates. Out of a great number sown at one time only two had germinated by the end of the third week, the others taking a longer

time. The spore remains attached for some time after the formation of antheridia.

The gametophyte is a filamentous protonema, irregularly branched, bearing both antheridia and archegonia on the same filaments; and producing rhizoids from specially modified cells which are inhabited by a symbiotic fungus.

The antheridia occur singly, or in groups on special branches bearing antheridia alone. They are produced in great numbers though but few ripen. They are simple in their structure and the first wall formed in the antheridium is parallel with the wall cutting it off from the lateral branch, forming a pedicel. A small number of antherozoids are produced in an antheridium, which are enclosed in a membrane when they escape from the antheridium.

The archegonia arise at, or near, the base of the filaments, either directly on the filament or, more often, on cushions formed by the division of the cell of the filament. They are characterized by the uniformity of the neck rows and the large size of the stigmatic cells.

The foot is a large, well-defined organ, remaining attached to the protonema for some time after the formation of the third frond, carrying nourishment from the gametophyte to the embryo which is far advanced before it breaks through the calyptra.

The primary root is persistent. The second and third roots have a vestigial sheath through which they do not break until after the development of the root-cap. The root-cap consists of four large pear-shaped cells inflated on the side away from the root tip.

The rhizome is erect, always forming a protective covering over the growing end; the trichomes are large, turn brown early, and are persistent.

There is a central concentric bundle with a well-marked endodermis. Sclerosis takes place in the entire cortex, the cells of which, with the epidermis, are filled with starch. The epidermis and cortex are often invaded by a fungus hypha.

The sterile and fertile leaves have two rows of large stomata, on the dorsal side, alternating with two or more rows of glands; these glands are small and sometimes wanting on the fertile leaf. The young leaves are more or less completely clothed with

trichomes. Warts or swellings occur from the epidermal cells on both surfaces, though more numerous on the ventral side.

The bundles appear collateral with a well-marked endodermis. The mesophyll tissue is composed of thin-walled cells, branched in a stellate manner.

Explanation of Plates

Plates 1, 2, 3 and 4 were drawn from a magnification three times as great as expressed in the numbers which represent the magnification of the figures as they stand in the reproduction.

PLATE 1

1. Different views of the spore, $\times 80$.
2. Spore, $\times 140$.
3. Portion of exospore, $\times 333\frac{1}{3}$.
4. Ridge and fissure in exospore seen from above, $\times 195$.
- 5-17. Different stages in the germination of the spore, $\times 58\frac{1}{3}$. *a*, filament; *b*, rhizoid; *c*, *c*, new branch.
18. Germinating spore of *Botrychium obliquum*, two weeks and five days, $\times 58\frac{1}{3}$. Sown at same time as *Schizaea* spores. The last-named did not start to germinate until after three weeks.
19. Germinating spore found in soil on August 28, $\times 80$. *a*, Indication of cross-wall.
20. The same on August 29. *a*, cross-wall formed.
21. The same on August 31, $\times 30$.
22. On September 4, $\times 30$.
23. On September 5, $\times 30$.
24. Spore found in soil on September 5, $\times 30$. *a*, antheridia; *b*, swelling at base of terminal antheridium.
25. The same with wall formed at *a*.
26. Filament of four cells with antheridium showing mother-cells of antherozoids (*a*). *b*, Rhizoid, $\times 80$.
27. Sporangium with spores germinating inside, $\times 30$. Owing to position in which the sporangium fell when sown—the filaments from the spores are not sent out through the regular fissure at *a*.

PLATE 2

- 28, 29, 30 and 31. Methods of branching of the protonemal filaments.
- 32 and 33. Cells of the filament dividing.
- 34 and 35. Cells of the filament becoming moniliform.
36. Young spherical cells with the longitudinal wall (*a*) just forming, $\times 80$.
37. Older stage of the same showing young rhizoids (*a*, *a*) and young branch starting from filament at base of spherical cells *b*, $\times 80$.
38. Portion of filament showing spherical cells, antheridia, and archegonia. *a*, spherical cells; *b*, rhizoids; *c*, fungus in spherical cells; *d*, antheridia; *e*, archegonium, $\times 30$.
39. Shows position of spherical cells, $\times 30$.
40. Abnormal condition. One cell of the filament giving rise to one spherical cell, and a cell of the filament next above giving rise to two, $\times 30$.
41. End of rhizoid showing fungus penetrating into the cell. Shaded portions are hyphae which are inside the rhizoid, $\times 195$.

18 BRITTON AND TAYLOR: LIFE HISTORY OF SCHIZAEA PUSILLA

42. Upper part of same showing portion of spherical cell with the bladder-like hyphae (*b*). A hypha in rhizoid. $\times 195$.

43. Spherical cells filled with fungus *a*, $\times 140$.

PLATE 3

44, 45, 46 and 47. Different ways of branching of antheridial filament.

48. One of the antheridial branches with antheridia in different stages of completion. *a* shows one filament giving rise to three, $\times 30$.

49, 50, 51, 52, 53, 54, 55 and 56. Stages in formation of the antheridium. Fig. 49, $\times 80$, first cell sent out from main filament. Fig. 50, $\times 30$, later stage showing first wall cut off near tip. Fig. 51, $\times 80$, older stage. Terminal cell *a* becomes the antheridium; cell *b* the pedestal. Fig. 52, $\times 140$, *a*, cap cell; *b*, mother cells of the antherozoids. Fig. 53, $\times 140$, later stage. Fig. 54, $\times 140$, ripe antheridium before splitting cap-cell. Fig. 55, $\times 333\frac{1}{3}$, antherozoids still in membrane. Fig. 56, empty antheridium.

57. Branch showing antheridia and archegonia. All the antheridia but *a*₂ are aborted, $\times 16\frac{2}{3}$.

58. Young archegonium, $\times 140$.

59. Young archegonium, $\times 30$. *a*, canal cell; *b*, ventral canal cell; *c*, egg cell.

60. Older stage of same before opening, $\times 80$.

61. Looking down on the four stigmatic cells of the archegonium, $\times 80$.

62. Archegonium opening, $\times 80$.

63. Showing large stigmatic cells (*a*) folding back, $\times 80$.

64. Cell of the filament dividing up before the formation of the archegonia, $\times 140$.

65. The same with an archegonium, $\times 30$.

PLATE 4

66 and 67. Upper and under view of egg cell after fertilization enclosed in the calyptra, $\times 30$.

68. Young embryo, $\times 30$.

69. *a*, gametophyte with archegonium. *b*, foot; *c*, leaf; *d*, stem of sporophyte, $\times 30$.

70. Young sporophyte. *a*, foot; *b*, leaf; *c*, stem; *d*, trichomes; *e*, gland on root; *f*, calyptra, $\times 80$.

71. Young sporophyte. *a*, foot; *b*, root; *c*, frond; *d*, calyptra.

72 and 73. Two stages in the growth of the sporophyte showing curled tip of frond. Marking the same in both. *a*, gametophyte; *b*, sporophyte; *c*, calyptra, $\times 12\frac{1}{3}$.

74. *a*, Rhizome; *b*, root; *c*, first leaf; *d*, trichomes.

Plates 5, and 6 were drawn from a magnification twice that expressed in the numbers which represent the magnification of the figures as they stand in the reproduction.

PLATE 5

75. Sporophyte still attached to gametophyte after the formation of the third leaf. *a*, foot; *b*, portion of calyptra; *c*, root; *d*, young root, the dotted lines indicate root-cap which can be seen through the vestigial covering; *f*, leaf; *g*, rhizome; *h*, trichomes which cover tip of young leaf and rhizome; some have been removed to show glands on leaf; *i*, gametophyte, $\times 45$.

76. Young root just emerging from its covering, $\times 87\frac{1}{2}$.

77. Root-cap; here shown in five series.

78. Cross-section of root. *a*, thickened inner walls of cells of the ground tissue next to endodermis (*b*); *c*, phloem; *d*, xylem, $\times 202\frac{1}{2}$.

79. Showing rhizome with four leaves and five roots; *a*, rhizome; *b*, roots; *c*, trichomes (the internode here represented is unusually long and distinct), $\times 8$.

80. Cross-section of rhizome not far from tip, $\times 120$. *a*, cells filled with starch; *b*, endodermis; *c*, phloem; *d*, xylem; *e*, fungus hyphae entering epidermal cells.

PLATE 6

81. Surface view of dorsal side of sterile leaf, showing the two rows of stomata with the glands alternating with them, $\times 120$.

82. Portion of epidermis of sterile leaf with three stomata, *a*, *b*, *c*. *a*, shows the chlorophyll grains; in *b* the contents have been removed to show the original cross wall (*d*) between the epidermal cells, and the way the guard cells (*e*) rest on epidermis at *c*, $\times 210$.

83. Oblique view of sterile frond showing raised stomata (*a*).

84. Longitudinal section of same. *a*, epidermal cells; *b*, one guard cell of stoma; *c*, air cavity.

85. Cross-section of same. *a*, guard cells; *b*, air cavity, $\times 210$.

86. Five diagrams showing development of stoma. 1 *b*, cross-wall between epidermal cells; 2 *b*, mother cell of stoma with U-shaped wall; *c*, formation of longitudinal wall through mother cell dividing it into the two guard cells; *d*, shows curve in original cross-wall, and the splitting of the longitudinal wall. The dotted line indicates the relative size of the guard cells which have started to swell. In *c*, the stoma is complete; 1 *c*, original cross-wall; 2 *c*, guard cells.

87. Diagram of cross-section of sterile leaf showing the two rows of stomata (*c*). *a*, bundle; *b*, endodermis, $\times 45$.

88. Bundle from sterile leaf. *a*, endodermis; *c*, phloem; *d*, xylem, $\times 210$.

89. Mesophyll tissue from sterile leaf, $\times 210$.

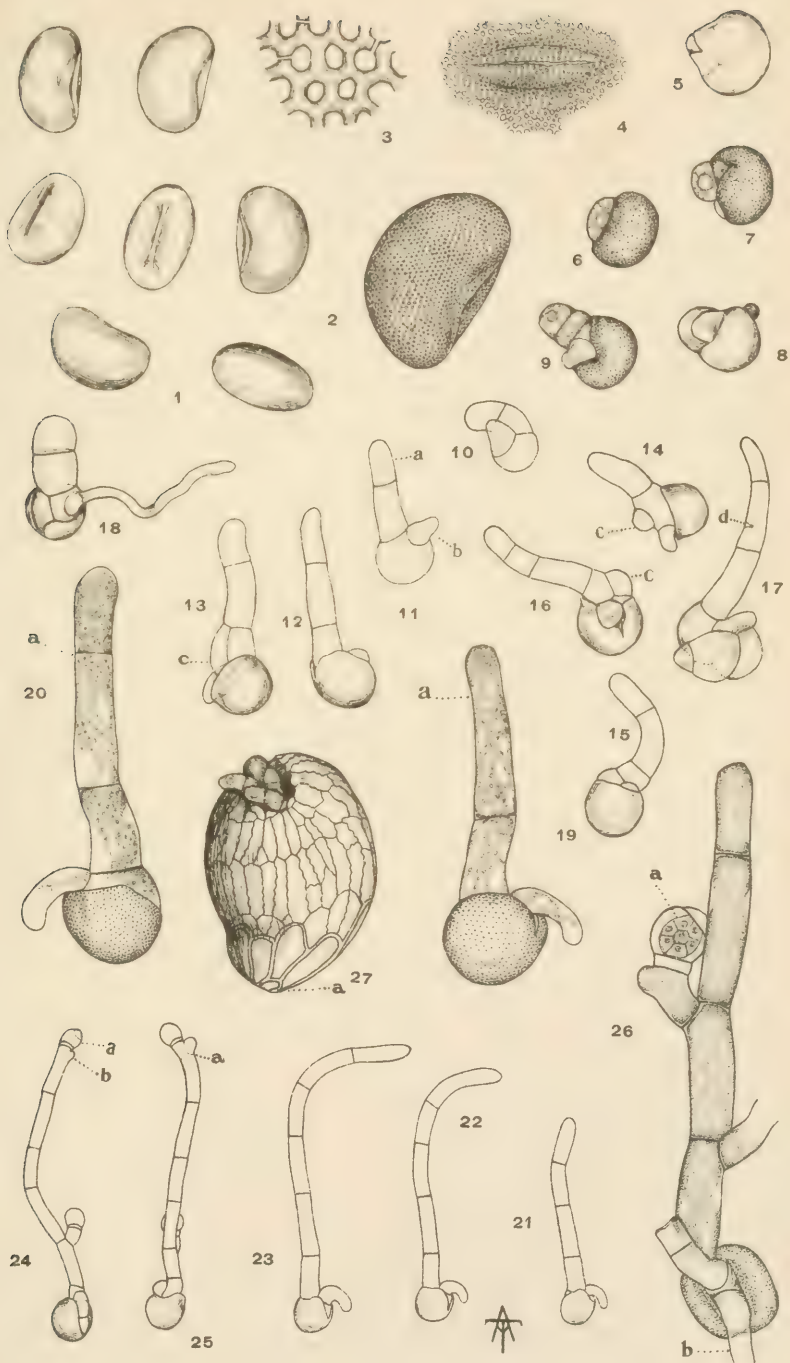
90. Cross-section of a young sterile leaf with a rudimentary bundle, marking as in Fig. 88, $\times 210$.

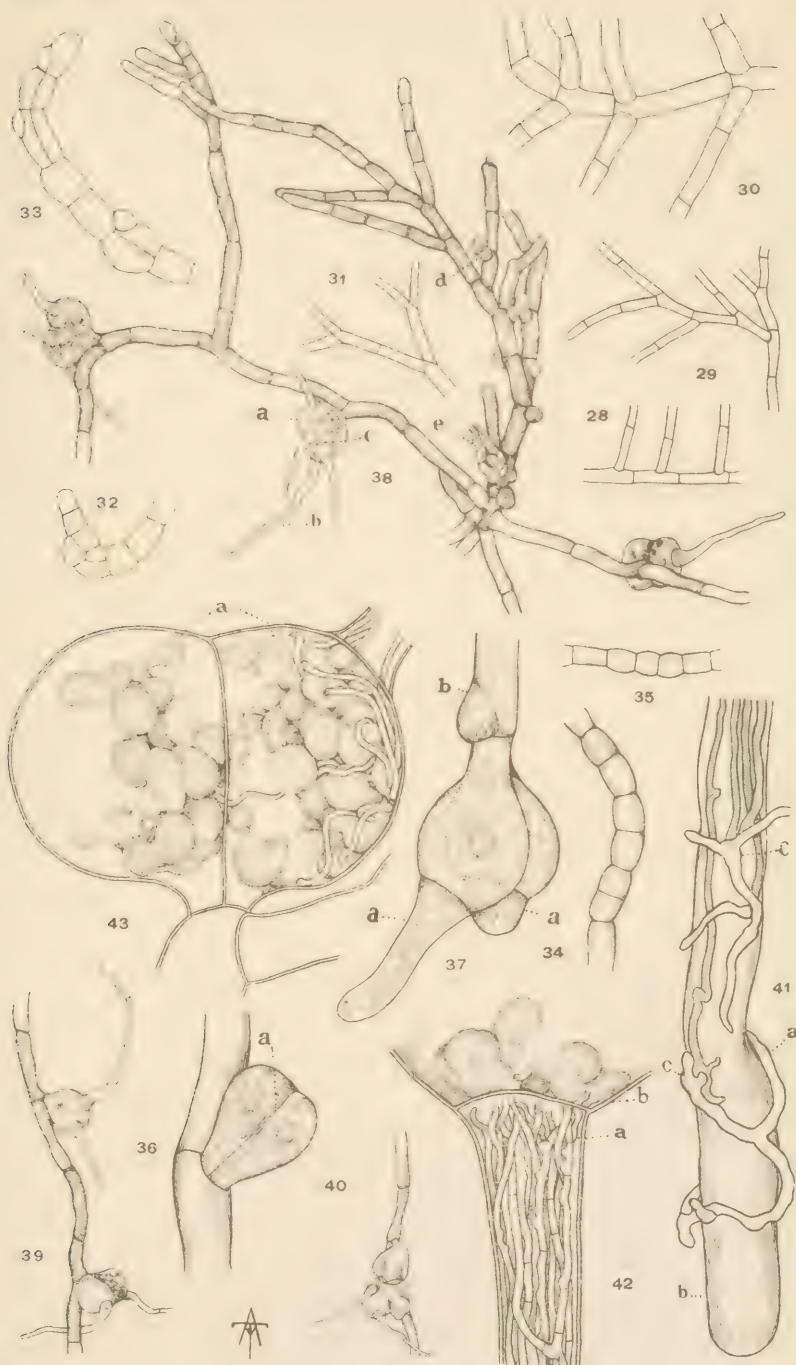
91. Diagram of cross-section of fertile leaf, marking as in Fig. 87, $\times 45$.

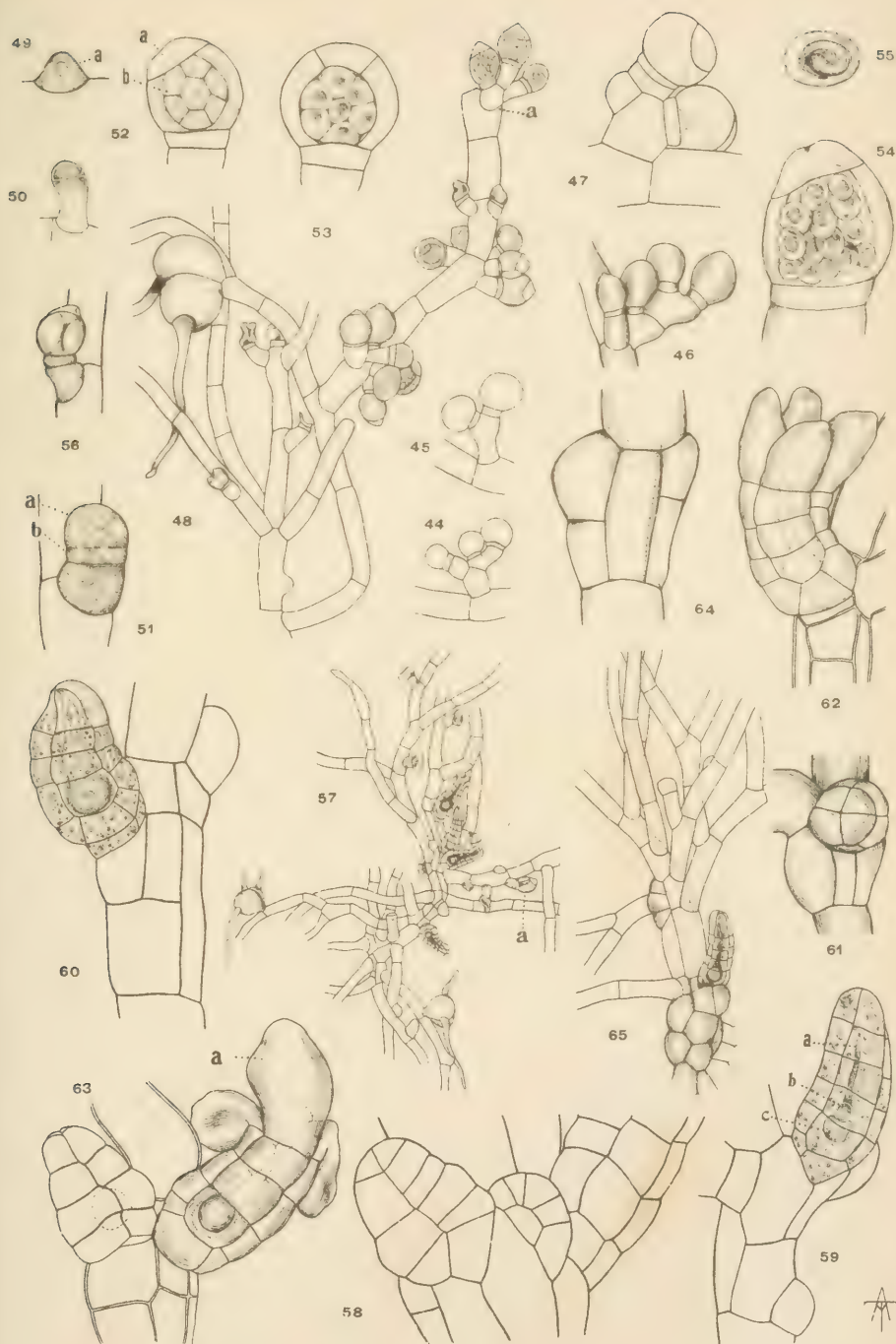
92. Stoma seen in cross-section of sporophyll, $\times 210$. *a*, stoma; *b*, air space.

93. Two epidermal cells from cross-section of sporophyll showing warts (*a*), $\times 210$.

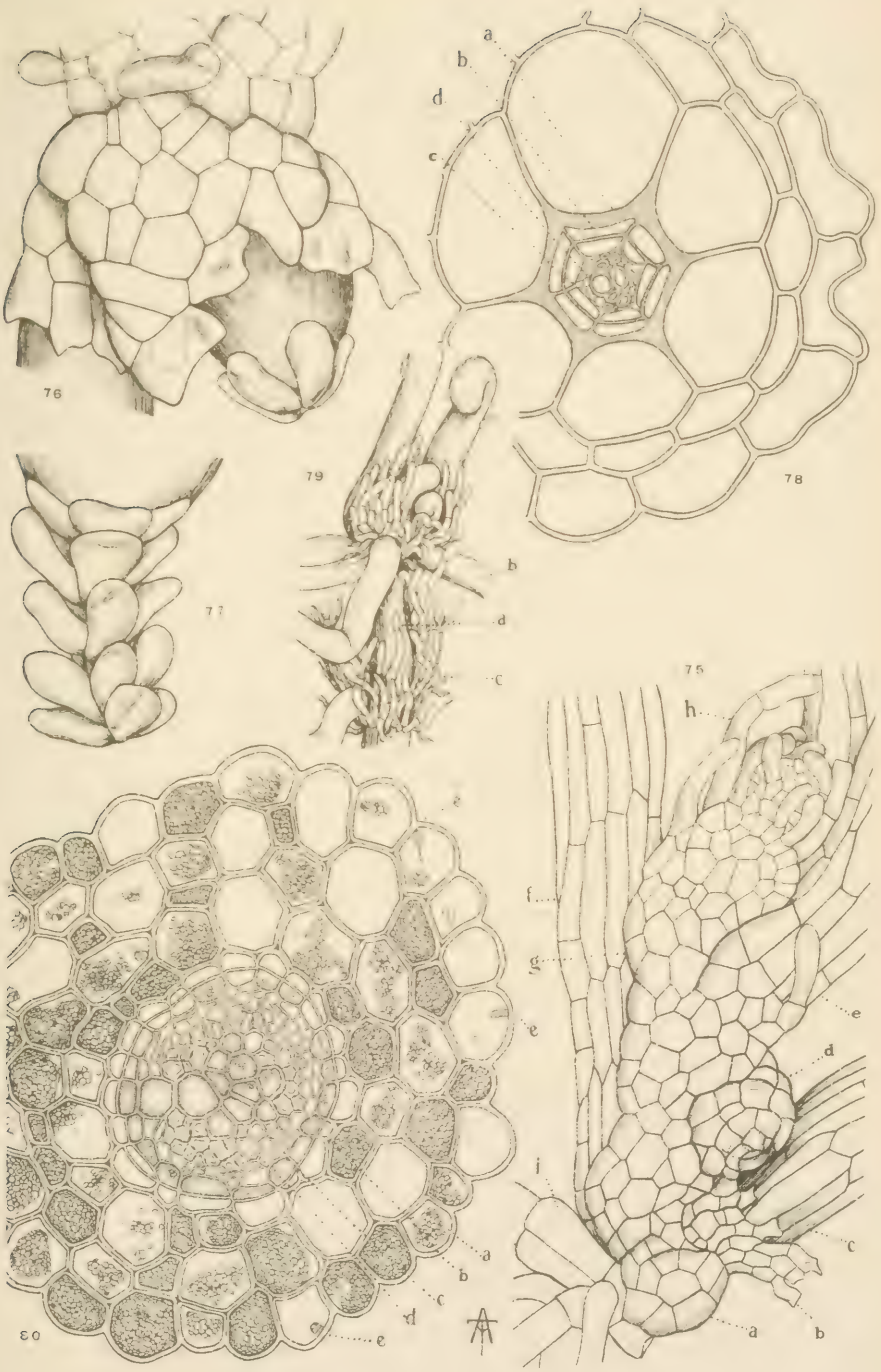
94. Cross-section of bundle in sporophyll, marking as in Figs. 88, 90, $\times 210$.

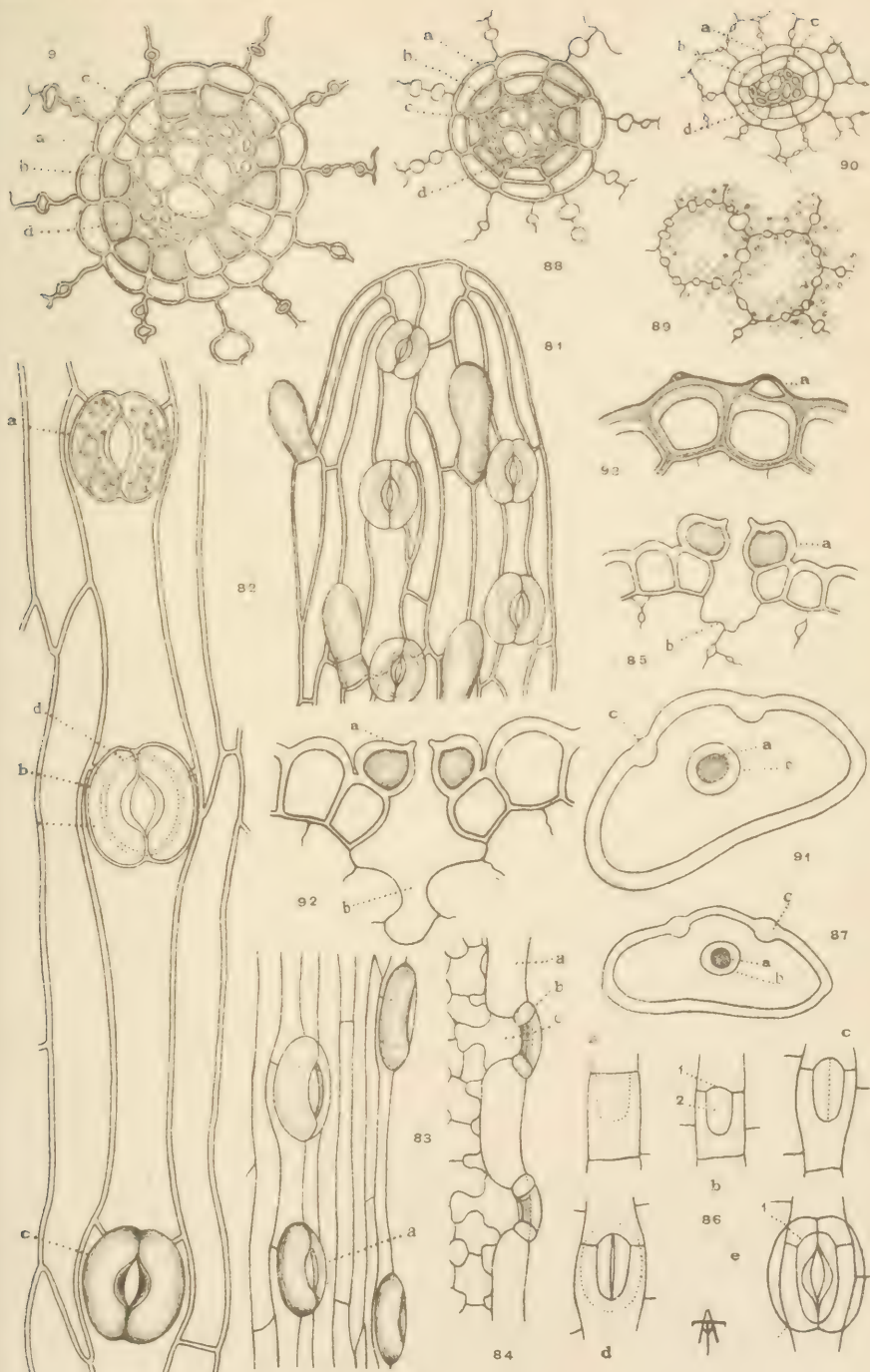












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FLORA.—IV

BY P. A. RYDBERG

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Studies on the Rocky Mountain Flora.—IV

BY P. A. RYDBERG

***Arnica tomentulosa* sp. nov.**

A leafy perennial with slender horizontal rootstock. Stem villous, about 4 dm. high: leaves oblanceolate, obtuse, sessile or the lower with short-winged petioles, denticulate, finely villous-pubescent, almost tomentulose, with two pairs of stronger veins, the larger 13 dm. long, somewhat yellowish: heads few, hemispherical; disk about 15 mm. high and 2 cm. broad: bracts ovate or ovate-oblong, obtuse, villous, 12–16 in number: rays light yellow, over 1 cm. long, 4 mm. wide.

This species is nearest to *A. mollis*, but differs in the broad obtuse involucre bracts. It grows at an altitude of about 2700 m.

WYOMING: Buffalo Fork, 1897, *F. Tweedy*, 523.

***Arnica tenuis* sp. nov.**

A low slender perennial with horizontal rootstock. Stem sparingly villous pubescent, about 2 dm. high, monocephalous: leaves usually 3 pairs, sparingly villous when young, entire; the lower two pairs oblanceolate or spatulate, the upper lanceolate: involucre turbinate-campanulate, villous, about 13 mm. high, 10–12 mm. broad: bracts linear, 1–1.5 mm. wide, green; rays orange, 16–18 mm. long and 4 mm. wide.

This species resembles *A. gracilis* in the size of the plant and form of the head, but the leaves are much narrower and the heads solitary. It is intermediate between that species and *A. fulgens*. It grows at an elevation of about 2200 m.

WYOMING: Big-Horn Mountains, 1899, *F. Tweedy*, 2094.

***Artemisia diversifolia* sp. nov.**

A white tomentose perennial with horizontal rootstock. Stems simple, leafy, white-tomentose, 5–10 dm. high: leaves densely tomentose on both sides, subsessile, 5–10 cm. long: the lower pinnately cleft into 3–5 narrowly lanceolate acuminate lobes, which are directed forward: the upper entire, linear-lanceolate, passing into the bracts of the inflorescence: inflorescence a narrow panicle, 1.5–3 dm. long: heads numerous, conglomerate, sessile, 3–4 mm. high and 3 mm. broad: bracts oblong or ovate-oblong, scarious-

marginated, densely villous-tomentose: flowers heterogamous, but all fertile, light yellow: receptacle glabrous.

This species belongs to the *A. Ludoviciana* group, and in many respects agrees with the original description thereof. It is, however, a western species, not growing near the region from which *A. Ludoviciana* was described. What the latter really is I have been unable to settle. The one that I think is the only one that has any claim for the name, is a lower plant from Missouri to Colorado, with shorter leaves, more green above, with more divergent lobes and brownish flowers. *A. diversifolia* grows on sandy beaches up to an altitude of 2200 m.

IDAHO: Priest River, 1900, *D. T. MacDougal*, 190 (type); Farmington Landing, Lake Coeur d'Alene, 1892, *Sandberg, MacDougal & Heller*, 509.

WASHINGTON: 1889, *G. R. Vasey*, 479.

WYOMING: Yellowstone Lake, 1899, *Aven & Elias Nelson*, 6603.

***Picradenia helenioides* sp. nov.**

A comparatively tall, finely pubescent plant with apparently only biennial root. Stem leafy, about 5 dm. high, with several to many erect branches: leaves rather firm, distinctly ribbed, finely pubescent; the lower petioled and with half clasping bases: basal leaves entire, very narrowly linear-ob lanceolate; middle stem-leaves erect, fully 1 dm. long, parted into 3-5 linear divisions: upper stem-leaves linear, entire: heads corymbose: involucre somewhat tomentose, 8-10 mm. high and often 15 mm. broad; outer bracts united only at the base, lanceolate, longer than the inner, 14-18 in number: rays orange, about 1 cm. long, 2-3 mm. wide, 3-toothed at the apex: achenes silky: scales of the pappus broadly lanceolate, acuminate.

It is nearest related to *P. biennis* (A. Gray) Greene; but differs in the yellowish green herbage, the erect branches, the broader segments of the leaves and the darker flowers. It grows in mountain valleys at an altitude of about 2700 m.

COLORADO: On Sangre de Christo Creek, 1900, *Rydberg & Vreeland*, 5495.

***Antennaria Piperi* sp. nov.**

Somewhat surculose-rosuliferous: basal leaves 2-4 cm. long, obovate or oval with a short petiole, densely floccose on the lower surface, only slightly so on the upper surface when young, but

soon glabrate, 1-ribbed or indistinctly 3-ribbed, generally distinctly mucronate : flowering stems 1-1.5 dm. high, somewhat glanduliferous above ; its leaves small and bractlike, oblanceolate or linear ; heads 5-7 in a short raceme : fertile heads 7-8 mm. high and 6-7 mm. in diameter ; its bracts imbricate in about 4 series, slightly floccose, green at the base, purplish in the middle and with a light brownish scarious margin above ; the outer short and ovate ; the inner lanceolate, acute : pappus very slender, filiform, dirty white ; sterile heads about 5 mm. high and about as broad ; its bracts broadly oblong, more floccose, brown and with a broader scarious margin of the same color as in the fertile head, obtuse or truncate ; pappus only slightly broadened above, white.

It is nearest related to *A. racemosa*, but differs in the more copious and more persistent tomentum, in the broader and brighter colored bracts of the fertile head and the broad scarious margins of those of the sterile one.

OREGON : Olympic Mountains, 1895, *C. V. Piper* (fertile plant in herbarium of Washington Experiment Station, Pullman) ; mountains of northern Oregon, *Wilkes Expedition* (sterile plant in the Torrey herbarium).

***Aster mollis* sp. nov.**

A strict perennial with a horizontal rootstock. Stem densely villous, almost tomentose, or in age more glabrate, 4-8 dm. high, simple below, with short flowering branches above ; leaves obovate to oblanceolate, 5-10 cm. long, densely and softly grayish pubescent on both sides, sessile, slightly clasping, and occasionally a little auricled at the base : heads terminating the short branches, hemispherical ; disk about 15 mm. high and broad ; bracts herbaceous, oblong, obtuse, villous-pubescent ; rays numerous, bluish purple, about 1 cm. long and 2 mm. wide.

This species reaches an elevation of 2200 m.

WYOMING : Big-Horn Mountains, 1899, *F. Tweedy*, 2029 (type).

WASHINGTON : Pullman, 1893, *C. V. Piper*, 1604.

***Townsendia Vreelandii* sp. nov.**

A dark green biennial, branching near the base. Stems and branches simple, erect, 1.5-4 dm. high, mostly erect, sparingly villous. Leaves numerous, all oblanceolate, short-petioled, glabrous, mucronate, 4-8 cm. long, 5-8 mm. wide : involucre about 15 mm. high and 25-30 mm. broad : bracts lanceolate, acuminate, scarious, light green with dark green center : rays

bluish purple, 12–15 mm. long, 2 mm. wide: achenes thin, oblong, truncate: pappus of 2 subulate bristles, with a few intermediate squamellae.

It is nearest related to *T. eximia*, but has larger heads, is more leafy, and even the upper leaves are oblanceolate. It grows at an altitude of 2500–3000 m.

COLORADO: Side of Veta Mountain, 1900, *F. K. Vreeland*, 639 (type); Veta Pass, 1900, *Rydberg & Vreeland*, 5404 and 5405; West Spanish Peak, 5406.

***Erigeron leucotrichus* sp. nov.**

Perennial with a somewhat branching rootstock. Stems about 2 dm. high, sparingly villous below, more copiously so above: basal leaves oblanceolate or spatulate, 3–5 cm. long, short-petioled, bright green and sparingly hairy: stem-leaves oblanceolate to linear, 1–2 cm. long; head solitary; involucre white-villous with multiceptate hairs; bracts very numerous, lanceolate, almost black, acuminate with spreading tips: rays very numerous, about 6 mm. long and 1 mm. wide, light purplish pink or white.

This species is nearest related to *E. melanocephalus*, but easily distinguished from it by the white, not black, hairs of the involucre. It differs from *E. simplex* in the taller habit, the larger heads and the darker bracts of the involucre. It grows at an altitude of about 2500 m.

WYOMING: Big-Horn Mountains, July, 1899, *Frank Tweedy*, 2003.

***Erigeron incanescens* sp. nov.**

(?) *Erigeron glabellus* var. *mollis* A. Gray, Proc. Acad. Phil. 1863: 64, in part.

A densely and finely cinereous pubescent plant with perennial rootstock. Stem simple, 1.5–3 dm. high, mostly ascending, striate densely pubescent, leafy: basal leaves oblanceolate or spatulate: stem-leaves about 5 cm. long and 1 cm. wide, oblong, oblanceolate or the upper lanceolate, sessile and somewhat clasping: heads 1–4; disk about 8 mm. high and 15 mm. broad: bracts very numerous in one series, narrowly linear, cinereous as the rest of the plant; rays pale blue or violet, very numerous, about 15 mm. long and less than 1 mm. wide.

From Dr. Gray's description, this species must have been included in *E. glabellus* var. *mollis*; but all specimens that I have

seen under that name belong to *E. subtrinervis* Rydb., which is its nearest relative. From this it differs in the dense grayish pubescence, the narrower stem-leaves, which are not 3-ribbed, and the lower habit. *E. incanescens* grows in rocky places at an altitude of about 3000 m.

COLORADO: West Spanish Peak, 1900, *Rydberg & Vreeland*, 5415.

***Erigeron viscidus* sp. nov.**

A low caespitose perennial. Stems ascending, a little over 1 dm. high, more or less hirsute and glandular-puberulent, especially above; leaves 3-5 cm. long, oblanceolate, dark green, sparingly hirsute and ciliate on the entire margins: heads few: disk about 1 cm. high and 15 mm. broad: bracts very numerous, subequal in one series, narrowly linear, fuscous, acuminate, glandular-puberulent, but not hirsute: rays very numerous, pale blue, about 8 mm. long and .5 mm. wide.

This species is intermediate between *E. glandulosus* and *E. macranthus*. It has the habit of the former, although larger, and the large heads and numerous narrow rays of the latter. It grows in wet ground, at an altitude of about 2700 m.

COLORADO: Near the Gray-Back Mining Camps, 1900, *Rydberg & Vreeland*, 5416.

***Valeriana acutiloba* sp. nov.**

A bright green plant with horizontal or ascending rootstock and polygamo-dioecious flowers. Fertile plant 4-5 dm. high: basal leaves entire with a short wing-margined petiole, 5-7 cm. long; blade spatulate or obovate, acute: stem-leaves usually 3 pairs, pinnately divided; lateral divisions lanceolate to linear, long-acuminate; the terminal one large, oblanceolate or of the uppermost very small leaves linear-lanceolate, entire or saliently toothed: cyme dense, contracted, 2-5 cm. long and about as wide; glandular-puberulent: bracts linear subulate, about 1 cm. long: flowers perfect; corolla funnelform, about 4.5 mm. long; tube proper about 1 mm.; fruit broadly ovate, about 4 mm. long: pappus about 7 mm.: staminate plant lower, 3-4 dm. high, with more sterile shoots, which have much longer leaves: stem-leaves usually only 2 pairs, less divided, with only 1-2 pairs of lateral divisions: cymes denser, flowers all or nearly all staminate: their corollas larger, 5-6 mm. long, more oblique; the limbs about 5 mm. wide.

This species has the dense cyme of *V. capitata*; but the plant is taller, the corolla shorter and is easily distinguished from all its

American relatives by the narrow, long-acuminate divisions of its stem-leaves. It grows in wet places, especially under snowdrifts, at an altitude of 2500–3300 m.

COLORADO: Near Gray-Back Mining Camp, Sangre de Christo Range, 1900, *Rydberg & Vreeland*, 5576 (type, fertile plant); Mountain near Veta Pass, 5575 (staminate plants); Bear Creek Cañon, 1895, *Ernst A. Bessey* (fertile); Pagosa Peak, 1899, *C. F. Baker*, 620.

***Campanula MacDougalii* sp. nov.**

A slender glabrous perennial, about 3 dm. high with slender horizontal rootstock. Leaves very thin: the basal ones and lower stem-leaves with slender petioles 2–4 cm. long: blades broadly ovate, 2–3 cm. long, coarsely sinuate-dentate: upper stem-leaves lanceolate to linear, entire; the largest 5–6 cm. long: sepals linear subulate, 10–12 mm. long, at last reflexed: corolla 13–15 mm. long, nearly of the same shape as that of *C. rotundifolia*: style exserted, straight: fruit not seen.

The species is nearest related to *C. Scouleri*; but is easily distinguished from that species by the lack of the sharp toothing of the leaves. The lower leaves resemble somewhat those of *C. rotundifolia*, and were it not for the exserted style and the smaller corolla it may be referred to the var. *Alaskana* of that species.

IDAHO: Priest Lake, 1900, *D. T. MacDougal*, 66.

***Castilleja linearis* sp. nov.**

A rather slender perennial, with a rootstock. Stem simple, 3–4 dm. high, finely villous pubescent: leaves narrowly linear, about 5 cm. long and 2 mm. wide, pubescent, entire or the upper with a pair of narrowly linear lobes: bracts broader, deeply cleft into three linear lobes, tipped with brick-red: calyx villous, 2–2.5 cm. long, cleft almost equally deeply in front and behind, more than half way down: lateral lobes linear, 8–10 mm. long: corolla 2.5–3 cm. long, greenish yellow: galea about 12 mm. long, with red margins: lower lip dark green, about 3 mm. long, 3-lobed.

This species resembles in habit most the subarctic *C. pallida*, but has the corolla of *C. mincata*. It grows in meadows at an altitude of about 2500 m.

COLORADO: Near West Spanish Peak, 1900, *Rydberg & Vreeland*, 5619.

Castilleja trinervis sp. nov.

A tall perennial with rootstock. Stem more or less villous, especially the upper portion, solitary, simple or branched, 3-6 dm. high: leaves dark green, finely puberulent, entire, acute, usually 3-ribbed; the lower linear, 5-8 cm. long and about .5 cm. wide; the upper lanceolate and often 15 mm. wide: lower bracts green, similar but shorter and broader and usually 3-5-lobed: the upper with almost crimson tips: calyx densely white villous, about 3 cm. long, equally cleft in front and behind, each division laterally cleft into two oblong lobes, 5-8 mm. long, tipped with the same color as the bracts: corolla about 4 cm. long, slightly curved, green, but the galea with almost crimson margins: galea about 15 mm. long: lower lip 4-5 mm. long, dark green, with three narrow lobes: style about 5 mm. longer than the corolla.

This species is nearest related to *C. rhexifolia* and *C. confusa*, but is characterized by the copious white villous pubescence of the upper part of the stem and the calyx. It grows in open woods at an altitude of 2700-3000 m.

COLORADO: Headquarters of Sangre de Christo Creek, 1900, Rydberg & Vreeland, 5620 (type); Gray-Back Mining Camps, 5621.

Castilleja luteovirens sp. nov.

A simple perennial with rootstock, often turning black in drying. Stem 3-4 dm. high, leafy, slightly pubescent when young, soon glabrate, except the upper portion which is slightly villous: leaves lanceolate to almost linear, 3-4 cm. long, 3-9 mm. wide, finely puberulent, 3-ribbed, acute, entire, or rarely the upper 3-lobed: lower bracts ovate, obtuse, entire, tipped with light greenish yellow or greenish white; the upper ones 3-toothed at the apex and greenish yellow throughout: calyx villous, 15-17 mm. long, almost equally cleft in front and behind, laterally cleft about 3 mm.; lobes lanceolate: corolla 22-24 mm. long, greenish; galea 6-7 mm. long with yellow margins; lower lip 2.5-3 mm. long, bluntly 3-lobed.

This species has been referred to *C. septentrionalis* and *C. pallida*, but differs from both in the broader, less acuminate leaves and broader, more entire yellowish bracts. Neither of the two species mentioned is found in the southern Rockies. Mostly all the material that has been determined as either belongs to the present species. This grows in meadows at an altitude of 1200-2700 m.

COLORADO: Sangre de Christo Creek, 1900, Rydberg & Vre-

land, 5616 (type) and 5617; Wahatoya Creek, 5618; Middle Park, 1861, *C. C. Parry*, 241; Chicken Creek, 1898, *Baker, Earle & Tracy*, 374; near Denver, 1869, *B. H. Smith*; Ford of Chama, 1859, *Newberry*, in Macomb's Expedition; Seven Lakes, Pikes Peak, 1894, *Ernst A. Bessey*.

WYOMING: Big-Horn Mountains, 1899, *F. Tweedy*, 2340; Laramie Plain, 1884, *C. S. Sheldon*, 80.

UTAH: Salt Lake City, 1879, *M. E. Jones*, 1051.

Mimulus gratioloides sp. nov.

A low, branched annual of more or less reddish color, generally less than 1 dm. high, somewhat viscid puberulent especially above. Leaves oblong-lanceolate, sessile, about 1 cm. long, sinuate-dentate: pedicels slender, in fruit 15–20 mm. long; calyx 7–8 mm. long, cylindraceous in fruit: lobes subequal, short, broadly ovate, acute, ciliate on the margins; corolla yellow, about 1 cm. long and 3 mm. broad, only slightly bilabiate: throat beardless.

This species is nearest related to *M. rubellus* and the specimens from Colorado referred to that species may belong here. *M. gratioloides* differs, however, in the smaller yellow corolla and the acute calyx-lobes. It grows in exposed places among rocks and gravel at an altitude of about 2300 m.

COLORADO: Butte, 5 miles southwest of La Veta, 1900, *Rydb. & Ireland*, 5660.

Pedicularis lunata sp. nov.

A perennial, perfectly glabrous up to the inflorescence, with a rather stout, but simple rootstock: stem about 4 dm. high, slightly striate and purplish: leaves alternate, dark green, 5–12 cm. long, pinnately divided to near the midrib; segments linear or linear-oblong, crenate: spike 15–20 cm. long, rather lax; bracts pectinately divided with prolonged endlobes, the lower often equaling the flowers in length, slightly arachnoid villous: calyx about 9 mm. long; its teeth broadly lanceolate, about 3 mm. long: corolla pinkish, over 2 cm. long; its tube about twice as long as the calyx, strongly curved; galea strongly arcuate, produced into a rather long beak and almost crescent-shaped; lower lip almost meeting the beak of the upper, very broad, indistinctly 3-lobed with large rounded lateral lobes.

The very broad lower lip, and long-beaked galea suggest somewhat *P. contorta* and *P. ctenophora*, but the corolla-tube is

much longer and the beak not spirally twisted. The species may therefore be placed with *P. Canbyi*, *P. Parryi* and *P. Hallii*, but the corolla and beak are much more arcuate. It is a handsome species growing at an altitude of nearly 2800 m.

WYOMING : Big-Horn Mountains, 1899, *F. Tweedy*, 2317 (type).

***Pentstemon erosus* sp. nov.**

A glabrous caespitose perennial, 2-4 dm. high. Basal leaves oblanceolate, short-petioled, 3-5 cm. long, entire, mostly acute : stem-leaves opposite, sessile, oblong or lanceolate, entire, acute or the uppermost acuminate : flowers in a dense interrupted spikelike inflorescence : calyx-lobes broadly ovate, almost cuspidate-acuminate, tinged with dark purple and white and with an erose-dentate margin : corolla purple with very dark limb : lower lip broad with 3 rounded reflexed lobes, bearded on the inside : upper lip with 2 erect narrower lobes : sterile stamens narrowly clavate, short-bearded.

This species is nearest related to *P. procerus*, but easily distinguished by the erose sepals and more reflexed lower lip. It grows at an altitude of 2000-2700 m.

COLORADO : Indian Creek Pass, 1900, *F. K. Vreeland*, 615 (type); South Park, 1873, *John Wolfe* (Wheeler Expedition), 293 ; Chicken Creek, West La Plata Mountains, 1898, *Baker, Earle & Tracy*, 658.

***Pentstemon Wilcoxii* sp. nov.**

An almost glabrous perennial with a caespitose caudex. Stems 3-6 dm. high, glabrous or slightly puberulent above, simple : leaves opposite, glabrous and somewhat glaucous, dentate with small sharp callous teeth, acute : the basal ones petioled, lanceolate : the lower stem-leaves sessile, oblanceolate or oblong, 3-5 cm. long ; the upper lanceolate and slightly clasping : inflorescence an elongated interrupted thyrses : branches 1-2 cm. long, fastigiate-cymose : calyx glabrous, about 4 mm. long, cleft $\frac{3}{4}$ its length : lobes lanceolate, acute, slightly margined below and there often sinuately toothed : corolla straight, purple, glabrous on the outside, about 15 mm. long ; the lower lip longer than the upper, slightly bearded within : sterile stamen club-shaped, with a short dense brown beard.

This species is probably nearest related to *P. humilis* ; but easily distinguished by the tall stems, the sharper toothed leaves, and the numerous purple flowers.

MONTANA : Kalispell, 1900, E. V. *Wilcox*, 370 (type in United States National Herbarium) and 368.

***Polemonium delicatum* sp. nov.**

A small glandular perennial with slender horizontal rootstock. Stem very slender, about 1 dm. high : leaves 3–8 cm. long ; leaflets 5–11 pairs, very thin, ovate, ovate-lanceolate or oblong, mostly acute, 3–10 mm. long : inflorescence usually branched ; branches 3–4-flowered ; pedicels slender, 5–15 mm. long ; calyx glandular, 4–5 mm. long : lobes lanceolate, acute : corolla blue, open-campanulate, about 7 mm. high and 8 mm. broad : stamens about equalling the corolla.

This is nearest related to *P. parviflorum* Nutt., but is still smaller and characterized by its slender pedicels, small flowers and acute calyx-lobes. It grows at an altitude of over 3000 m.

COLORADO : West Spanish Peak, 1900, *Rydberg & Vreeland*, 5720 (type).

COLORADO OR NEW MEXICO : Canadian ?, *Dr. James*.

***Polemonium speciosum* sp. nov.**

A low viscid-villous plant, cespitose with a perennial rootstock. Stem 1–2 dm. high with 2–3 leaves : basal leaves numerous, 8–15 cm. long with wing-margined rachis ; leaflets opposite, 7–9 pairs, ovate, 6–12 mm. long, acute : stem-leaves similar but smaller : inflorescence capitate : calyx viscid-villous, 15–20 mm. long, cleft to about the middle : lobes lanceolate, acute : corolla pale blue, deeply campanulate-funnelform, 2–2.5 cm. long : limb about 1.5 cm. broad.

The form of the corolla, the dense capitate inflorescence and the viscid pubescence place this species nearest *P. viscosum*, and *P. confertum*, but the leaflets are not verticillate, the corolla is larger than that of the former and broader than in the latter.

COLORADO : Mount Garfield, 1900, *Fred. Clements*.

***Gilia candida* sp. nov.**

A glandular perennial with short caudex. Stems often more than one, ascending or erect, simple, 4–6 dm. high, leafy : leaves rather fleshy, divided into linear-filiform, spinulose-tipped segments ; the upper gradually smaller : inflorescence a very narrow panicle : branches usually very short and few-flowered : flowers subsessile : calyx glandular-pubescent, about 8 mm. long ; its lobes lanceolate, bristle-tipped : corolla white, or rarely pale pink, 2–3

cm. long, salverform: its lobes oval or obovate, obtuse: stamens inserted unequally below the throat, included.

This species is nearest related to *G. aggregata*; but differs in the white corolla and its rounded obtuse lobes. It is also lower and the upper leaves more reduced. It grows on dry hillsides at an altitude of 2000–2700 m.

COLORADO: Mesas near La Veta, 1900, *F. K. Vreeland*, 602 (type); Veta Pass, 1900, *Rydberg & Vreeland*, 5730; Calham, 1893, *Dr A. Saunders*.

***Phacelia alba* sp. nov.**

A viscid-villous annual or biennial, 2–4 dm. high. Stem leafy, strict and simple viscid-villous and glandular above: leaves twice interruptedly pinnatifid, about 1 dm. long, glandular-puberulent, hispid ciliate on the margins and veins; ultimate segments ovate or oblong, 3–6 mm. long: inflorescence branched, dense, in flowers almost capitate, but branches in fruit spiciform: flowers nearly sessile, 2-ranked: calyx glandular, cleft to near the base: sepals broadly linear, obtuse, about 2 mm. long, about one third shorter than the white corolla: the lobes of the latter rounded, crenate: appendages 10, broadly ovate: stamens and style much exserted: capsule ovoid, about 6 mm. long: seeds often solitary in each cavity, finely pitted.

This species is nearest related to *P. Neo-Mexicana* and *P. Poppei*, resembling the latter most in habit, but having the viscid-pubescent and the crenate corolla-lobes of the former. It differs from both in the small white corolla and the long-exserted stamens. It grows in mountain valleys at an altitude of 1800–3000 m.

COLORADO: Sangre de Christo Creek, 1900, *Rydberg & Vreeland*, 5755 (type); Valley of Upper Arkansas River, 1873, *John Wolfe* (Wheeler Expedition), 99; Headwaters of Clear Creek, 1861, *C. C. Parry*, 314.

NEW MEXICO: Ruidoso Creek, White Mountains, 1895, *E. O. Wootton*.

***Lappula calycosa* sp. nov.**

A hirsute annual, simple below, branched above with long virgate branches. Stem hirsute, 3–4 dm. high: leaves oblong, obtuse, 3–4 cm. long, 7–8 mm. wide; those of the branches smaller: pedicels short, in fruit 2–3 mm. long, generally 4 mm. below the leaves: corolla pale blue, about 1.5 mm. long, and 1 mm. broad: calyx-lobes enlarged in fruit, foliaceous, 4–6 mm.

long and reflexed: fruit about 4 mm. in diameter: nutlets surrounded by a single row of subulate glochinate prickles, somewhat flattened at the base but not united into a wing-border: back of the nutlets strongly muricate.

It is nearest related to *L. occidentalis* (Wats.) Greene, but differs in the oblong obtuse leaves, the enlarged and reflexed fruiting calyx-lobes, and the virgate branches. It grows in deserted fields at an altitude of about 2000 m.

COLORADO: Walsenburg, 1900, *Rydberg & Vreeland*, 5715.

***Lappula cupulata* (A. Gray)**

Echinosperrum Redowskii var. *cupulata* A. Gray, Bot. Calif. 1: 530. 1876.

I think that this should be regarded as distinct from *L. Texana* (Scheele) Britton, as the habit is quite different. *L. cupulata* is diffuse, branching at the base, with elongated branches, while *L. Texana* is simple at the base, and branched above with short branches.

L. Texana is a southern plant, ranging from Texas to New Mexico. The range of *L. cupulata* is from Nevada to Nebraska, south to Colorado.

***Cryptanthus minima* sp. nov.**

A dwarf hirsute annual, beginning to bloom when only 1 cm. high. Stems several, erect, in the specimens seen only 1-4 cm. high, long hirsute: leaves spatulate or oblanceolate obtuse, hirsute on both sides, 5-15 mm. long and 2-3 mm. wide: flowers crowded, 2.5-3 mm. long, subsessile: lobes of the calyx linear, hispid: corolla white; limb a little over 1 mm. broad; nutlets whitish, about 1 mm. long, dissimilar; 3 ovoid, strongly muricate; the fourth somewhat larger, smooth; the inside edge with a slender groove, triangular-dilated at the base.

In size and general habit, this species is strikingly like *C. pusilla*; but the fruit is different; the nutlets being dissimilar, one of them smooth, and all with rounded lateral angles and more rounded backs. The specimens of our collection are rather young and only two fully developed fruits were found. *C. minima* was found on dry hillsides at an altitude of about 2200 m.

COLORADO: Cucharas River, above La Veta, 1900, *Rydberg & Vreeland*, 5697.

Mertensia lineariloba sp. nov.

A slender perennial with glabrous simple stem, 2-3 dm. high, basal leaves 5-15 cm. long, long-petioled; blades oblanceolate, obtuse; stem-leaves subsessile, linear or linear-lanceolate, acute, 3-6 cm. long, 4-9 mm. wide, strigose above, glabrous beneath; flower clusters 3-4-flowered in the axils of the upper leaves; pedicels very slender, 2-6 mm. long, strigose; calyx divided to near the base; lobes linear, acute, 3-4 mm. long, almost equaling the tube of the corolla, glabrous on the back, but hispid ciliate on the margins; corolla blue, 7-8 mm. long, tube nearly of the same length as the throat and limb; the latter 4-5 mm. long; stamens almost equaling the corolla; filaments dilated, and broader than the anthers.

It is nearest related to *M. linearis*, but characterized by the narrow, strongly ciliate calyx-lobes and the filiform pedicels. It grows in shaded situations at an altitude of 2500-2700 m.

COLORADO: West Indian Creek, Trichera Range, 1900, *Rydb. & Vreeland*, 5691 (type); near Empire, 1885, *H. N. Patterson*, 115.

Mertensia ovata sp. nov.

A low caespitose, somewhat fleshy perennial. Stems 1-1.5 dm. high, glabrous; leaves 2-5 cm. long, 1-1.5 cm. wide, minutely strigose above, glabrous beneath; the lower obovate and short-petioled; the upper broadly ovate and sessile; flower-cluster dense; pedicels very short; calyx cleft to near the base; sepals lanceolate, ciliate on the margin, about 4 mm. long and one third shorter than the corolla-tube; corolla 10-12 mm. long; its tube nearly one half longer than the throat and limb; the latter about 7 mm. broad; stamens nearly equaling the corolla; filaments dilated and broader than the anthers.

This species is probably nearest related to *M. lanceolata*; but differs in the stunted habit and the broad leaves. It grows among rocks, at an altitude of 2800-3500 m.

COLORADO: West Spanish Peak, 1900, *Rydb. & Vreeland*, 5690 (type) and 5690a.

Mertensia obtusiloba sp. nov.

A low caespitose perennial. Stems ascending, glabrous, 1-2 dm. high; lower leaves spatulate or oblanceolate, obtuse, tapering into a winged petiole, dark green, glabrous beneath, minutely strigulose above, glabrate in age, 3-5 cm. long; the upper broadly lanceolate, sessile; flower-clusters several from the axils of the

upper leaves : pedicels very short, often sparingly strigulose : calyx divided to near the base ; sepals oblong, obtuse, ciliate on the margins, 2–3 mm. long, scarcely more than half as long as the tube of the corolla : corolla dark blue, about 7 mm. long : tube nearly equaling the throat and limb : stamens short, included in the tube, filaments very short, not broader than the anthers.

This species is nearest related to *M. Tweedyi*, but differs in the shorter, obtuse calyx-lobes, the broader and thinner leaves and the stem which is not depressed or prostrate. It grows at an altitude of 2000–3500 m.

COLORADO : Pikes Peak, 1900, *Fred. Clements* (type) ; Garden of the Gods and Pikes Peak, 1894, *Ernst A. Bessey* ; Argentine Pass, 1878, *Marcus E. Jones*, 54.

***Mertensia membranacea* sp. nov.**

A tall erect perennial with a rather thick tap-root. Stem glabrous or sparingly hirsute above, 6–8 dm. high : leaves all petioled, or the upper sessile ; blades ovate, acute or more often short acuminate, 4–8 cm. long, 1.5–4 cm. wide, very thin, hispid-stringulose on both sides : flower-clusters terminal and in the axils of the upper leaves, branched and many-flowered : pedicels 5–10 mm. long, hispidulous : calyx-lobes 2–3 mm. long, hispidulous, lanceolate, acute, one-third or one-fourth as long as the tube of the corolla : corolla about 1 cm. long ; the pale blue or almost white tube longer than the dark blue limb and throat : limb about 4 mm. broad : stamens much shorter than the limb ; filaments dilated and broader than the anthers : nutlets strongly rugose and spotted.

This species is related to *M. paniculata*. Mr. Bessey and myself collected it in 1897, but as the specimens were rather poor, they were referred doubtfully to that species. As more and better specimens have now been received, it has been possible to draw a description. It differs from *M. paniculata*, in the thinner leaves which almost always show an acumination, in the short calyx-lobes which scarcely enlarge in fruit and the smaller and numerous flowers. It grows in moist places at an altitude of 300–2000 m.

IDAHO : Priest River, 1900, *D. T. MacDougal*, 3 (type) ; Cedar Mountain, 1892, *Sandberg, MacDougal & Heller*, 420.

MONTANA : Electric Peak, 1897, *Rydberg & Bessey*, 4864.

***Mentzelia ctenophora* sp. nov.**

A diffuse caespitose scabrous perennial. Stems 3–6 dm. long, branched, in age straw-colored : lower leaves linear or linear-lan-

ceolate in outline, tapering at both ends, often 2 dm. long : the upper lanceolate with a broad base : all pectinately laciniate with linear-oblong divergent obtuse lobes ; hypanthium cylindrical, 15–18 mm. long ; sepals ovate-lanceolate, acute, 4–5 mm. long : petals obovate, light yellow, about 8 mm. long : seeds irregularly angled, but not winged, finely muricate.

This species is perhaps nearest related to *M. albicaulis*, but differs in the large size of the plant, the diffuse habit, and the larger flowers. It was collected on railroad banks and in loose barren soil on hillsides, at an altitude of 1800–2100 m.

COLORADO : On Cucharas River, below La Veta, 1900, *Rydberg & Vreeland*, 5769 (type) ; near Walsenburg, 5768.

***Impatiens aurella* sp. nov.**

A slender glabrous annual, about 6 dm. high. Petioles 1.5–3 cm. long : leaf-blades ovate or oval, thin, bright green, a little paler beneath, 4–5 cm. long, coarsely toothed, acute ; teeth and apex finely mucronate : peduncles ascending, mostly 2-flowered : bracts minute, linear, about 2 mm. long : flowers orange, not mottled : sack conical, about 1 cm. long and 6 mm. broad at the base ; its spur recurved, about 8 mm. long.

This is nearest related to *I. biflora*, but differs in the much smaller flowers, which are scarcely more than half the size of that species and without any spots, the comparatively longer spur and less pale leaves. It grows in swamps at an altitude of about 600 m.

IDAHO : Priest River, 1900, *D. T. MacDougal*, 20.

***Geranium nervosum* sp. nov.**

A tall perennial with thick root and short caudex. Stems 4–8 dm. high, minutely retrorsely strigose, in age more glabrate : basal leaves with petioles 2–4 dm. long ; blades reniform in outline, 8–12 cm. in diameter, finely strigose on both sides, divided to near the base into 5–7 obovate-cuneate or oblanceolate-cuneate divisions which are again 2–3-cleft and coarsely toothed : stem-leaves none, except those subtending the inflorescence ; these sessile, 3–5-cleft ; branches of the cymes and calyx very densely glandular pubescent : sepals oval, 8–9 mm. long, terminated by a filiform tip, 1–2 mm. long : petals broadly obovate, 15–18 mm. long, pale violet or almost white, with dark purple streaks : carpels as well as their column densely glandular ; the latter nearly 2 cm. long : style beyond the column about 5 mm. : seeds glabrous, minutely reticulate.

This species is somewhat intermediate between *G. viscosissimum*

and *G. Richardsonii*, having the general habit, the leaves and pubescence of the stem of the latter, but the densely glandular pubescence of the inflorescence and the calyx and carpels of the former. The color of the flower is most like *G. Richardsonii*, but scarcely pure white and with much more prominent veins. It grows at an altitude of 1800–2700 m.

WYOMING: Fish Creek, Teton Forest Reserve, 1897, *F. Tweedy*, 494 (type).

COLORADO: Continental Divide, Routt County, 1894, *C. S. Crandall*.

***Lupinus candicans* sp. nov.**

A low caespitose perennial, densely white-silky throughout. Stems ascending, 1.5–2 dm. high, 3–4-leaved, often branched: stipules linear subulate, 5–8 mm. long: petiole 3–8 cm. long: leaflets about 7, densely white-silky and shining, 1.5–2.5 cm. long, oblanceolate, acute, mucronate, mostly conduplicate: raceme rather dense, 3–8 cm. long on a peduncle 2–5 cm. long: bracts small and early deciduous: calyx densely silky-villous, only slightly saccate on the upper side; lower lobe about 4 mm. long: banner dark blue with a light brown spot, about 7 mm. long, very broad, and with the sides strongly reflexed; wings dark blue, as well as the banner glabrous, about 9 mm. long and about equaling the keel: the latter whitish, tipped with dark purple: pod densely white-silky, 3–4-seeded.

This species has the white pubescence of *L. sericeus* and *L. Helleræ*; but is in every way a much smaller and more caespitose plant: the flowers are much smaller and of a darker and more intense blue.

MONTANA: (locality not given), 1900, *E. W. Wilcox*, 451 (type in U. S. Nat. Herb.); Boulder, 125 and 129, in part; Big Timber, 385; Highwood Mountains, 42; Columbia Falls, 1897, *R. S. Williams*.

***Lupinus cyaneus* sp. nov.**

A stout and tall perennial with rather simple caudex. Stem 4–9 dm. high, densely villous, but not white, very leafy and in age somewhat branched: stipules subulate, over 1 cm. long: petioles 5–10 cm. long: leaflets 7–11, oblanceolate, 3–9 cm. long, glabrous above, almost velvety beneath, acute: raceme long and dense, 1.5–2 dm. long: bracts rather persistent, often over 1 cm. long: flowers very numerous, 2–4 in each verticil, very short-pedicel: calyx white-velvety, somewhat saccate above: lower lobe about

8 mm. long : banner slightly hairy on the back, light blue, with a light brownish spot at the center, about 8 mm. long : wings light blue, about 1 cm. long, equaling the keel, which is whitish with purple tip : pod densely silky-villous, about 25 mm. long and 8 mm. wide, 4-5-seeded.

This species has the general habit and the long dense raceme of *L. leucophyllus*, but is much greener and the flowers are much smaller and lighter in color. No. 435, cited below, is referred here doubtfully. It is more silvery and more branched and had apparently almost white flowers.

MONTANA: (locality not given), 1900, *E. F. Wilcox*, 446 (type in U. S. Nat. Herb.); Coal Spur, 435 (?) and 449 (the latter in fruit); Gallatin Valley, 1896, *J. H. Flodman*, 617.

***Astragalus sulphureus* sp. nov.**

A light green caespitose perennial. Stems ascending, about 4 dm. high, angled, glabrous, somewhat branched : stipules ovate to lanceolate, membranaceous, free from the petioles : leaflets 13-19, elliptic, obtuse or acutish, mucronulate, 12-30 mm. long, with a few scattered strigose hairs : spike dense and elongated : flowers ascending : bracts lanceolate-subulate, about 8 mm. long : calyx white-strigose with scattered black hairs : tube about 5 mm. long : lobes almost filiform, fully 5 mm. long : corolla light yellow : banner narrow, 15-18 mm. long, much exceeding the wings and keel : wings very narrow, only about 1.5 mm. wide : pod 2-celled, with dorsal suture deeply inflexed, deeply obcordate in section, about 1 cm. long, 3-4 mm. wide, strigose, with black hairs.

This species is closely related to *A. adsurgens*, but differs in the yellow, ascending flowers, narrow petals, more scant pubescence, the long slender calyx lobes and the black hairy pod. It grows at an altitude of 1600-3000 m.

COLORADO: Georgetown, 1895, *P. A. Rydberg* (type); along Platte River, Denver, 1878, *M. E. Jones*, 851.

***Aragallus villosus* sp. nov.**

Densely and intricately caespitose perennial. Leaves basal, numerous, 5-10 cm. long : leaflets 25-31, rather crowded but not verticillate, 1-1.5 cm. long, lanceolate, very acute, densely but somewhat loosely silky : scape about 1.5 dm. long, loosely silky, almost hirsute, with spreading hairs : spike dense, 4-5 cm. long : bracts linear or narrowly linear-lanceolate, 8-10 mm. long : calyx

white-silky villous; lobes very short, about 2 mm. long: corolla ochroleucous without any purple, 12–15 mm. long: keel very short and round, abruptly tipped with a small tip: pod thin, perfectly 2-celled, white-silky, about 1.5 cm. long, more than twice as long as the calyx, tipped with a slender beak which is abruptly hooked at the apex.

This belongs to the *A. campestris* group and is characterized by the coarse spreading pubescence of the scape and the ochroleucous flowers without any trace of purple.

MONTANA: Craig, 1900, *E. V. Wilcox*, 378 (type in U. S. Nat. Herb.).

***Trifolium lilacinum* sp. nov.**

A densely caespitose dwarf subscapose perennial with very deep root. The short branches of the caudex covered with the scarios stipules and remains of old leaves: leaves 3-foliolate, bright green; petioles 2–6 cm. long, strigose: leaflets elliptic or lanceolate-oblong, acute at each end, 1–2.5 cm. long, strigose: peduncle 5–12 cm. long, bracts minute, less than 1 mm. long, 3-toothed: flowers reflexed in fruit: calyx densely strigose; tube 3 mm. long; teeth subulate-filiform, 4–6 mm. long: corolla pale rose-purple or lilac, in age turning light brownish, about 1 cm. long; banner straight and obtuse.

This species is related to *T. dasyphyllum*; differing in the minute 3-toothed bracts and their shorter and comparatively broader leaflets. It is still nearer related to *T. acuminatus* Greene; from which it is distinguished by the smaller flowers and the not acuminate banner. It is an alpine plant growing among rocks at an altitude of about 3000 m.

COLORADO: West Spanish Peak, 1900, *Rydberg & Ireland*, 5950 (type), 5951 and 5952.

***Lathyrus leucanthus* sp. nov.**

A glabrous or slightly pubescent perennial with a very slender rootstock. Stem about 3 dm. high, angled: stipules very narrow, semi-sagittate: leaflets 2–4 pairs, elliptic, veiny, glaucous, acute, mucronate, 1–3 cm. long, 3–10 mm. wide: tendrils of the lower leaves mere tips; of the upper elongated and sometimes 3-divided: racemes short, in the axils of the middle leaves, 3–4 cm. long, 2–4-flowered: calyx glabrous, cleft to about the middle: lobes lanceolate, acuminate: corolla white, about 15 mm. long: banner broad.

This is nearest related to *L. Arizonicus*, but differs in the broader leaves and banner. It grows at an altitude of 2400–3000 m.

COLORADO: Ojo, 1900, *Rydberg & Ireland*, 6020 (type); Pass Creek, 6021; West Indian Creek, 6022; mountain near Veta Pass, 6023; Veta Pass, 1890, *Mr. and Mrs. G. H. Hicks*, 19; Ridgway, 1895, *F. Tweedy*, 239.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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FURTHER STUDIES ON THE POTENTILLEAE.

BY P. A. RYDBERG.

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Further Studies on the Potentilleae

BY P. A. RYDBERG

I. WEST AMERICAN SPECIES

Potentilla horrida sp. nov.

A stout perennial with very thick woody root and a short caudex covered with the thick coriaceous brown remains of old leaves: stems ascending, 1.5–4 dm. high, stout, few-leaved, hirsute-villous: petioles of the basal leaves 5–10 cm. long, stout, densely hirsute-villous, broadened at the base and surrounding the stem: leaves digitate; leaflets usually 5, linear-oblong or oblong-lanceolate, obtuse, crenulate, 3–5 cm. long, 7–12 mm. wide, densely pubescent on both sides, almost velvety: pubescence at first white, later on brown, consisting of tomentum and longer silky hairs: stem-leaves similar or trifoliate, much smaller; the upper sessile; the stipules lanceolate to linear-subulate, 1–3 cm. long, adnate to the petioles: cyme rather congested: hypanthium and calyx densely pilose: bractlets lanceolate, acute, about half as long as the ovate-lanceolate sepals which are about 5 mm. long: petals yellow, broadly obovate, about 7 mm. long.

A species of the *gracilis* group, but resembling most *P. Hacmatochrus* in habit and pubescence. It differs, however in the coarser pubescence, the 5-foliate, instead of 7-foliate leaves and the yellow petals. The type specimens were found at an altitude of 2250 m.

MEXICO, STATE of CHIHUAHUA: Sierra Madre, near Colonia Garcia, 1899, *Townsend & Barber*, 16.

Potentilla brunnescens sp. nov.

A tall strict perennial with short scaly rootstock: stem 4–5 dm. high, pubescence, especially above, tinged with brown or purplish: basal leaves digitately 5–7-foliate; petioles often 2 dm. long, villous with spreading hairs; leaflets 4–7 cm. long, broadly oblanceolate in outline, brownish strigose on both sides, paler beneath, pectinately divided to near the midrib; segments linear, obtuse: stem-leaves similar but short-petioled or sessile, smaller: cyme many-flowered, corymbiform: hypanthium and calyx villous-strigose: bractlets linear, obtuse, about half as long as the

ovate-lanceolate, acute sepals: petals yellow, 5-6 mm. long, obovate, about one fourth longer than the sepals.

The species is a member of the *gracilis* group and nearest related to *P. flabelliformis*, from which it differs in the light brown or yellowish pubescence and the lack of tomentum on the lower surface of the leaves. The type was collected at an altitude of nearly 2000 m.

WYOMING: Spread Creek, in the Teton Forest Reserve, 1897, *P. Ledeb.*, 212.

***Potentilla Townsendii* sp. nov.**

A slender perennial with a deep root and a short caudex, covered by the brown remains of old leaves: stem ascending, 3-5 mm. high, sparingly silky: petioles of the digitate basal leaves 7-10 mm. long, slightly hairy; stipules adnate to the petioles; the free portion linear-subulate; leaflets 5-7, oblanceolate to almost linear, serrate, acute, glabrous above, sparingly hairy beneath, principally on the veins: stem-leaves 2-3, similar, but with shorter petioles: stipule large, 3-4 cm. long, lanceolate or ovate-lanceolate: cyme rather open: hypanthium and calyx silky-strigose: bractlets linear-lanceolate, equalling the lanceolate sepals: petals yellow, broadly obcordate, about 1 cm. long and almost twice as long as the sepals.

This species is perhaps nearest related to *P. heptaphylla*, but easily distinguished by the narrow leaflets and the larger flowers. It was collected at an altitude of about 2250 m.

MEXICO, STATE OF CHIHUAHUA: Sierra Madre, near Colonia Garcia, July 17, 1899, *Townsend & Barber*, 105.

***Potentilla filipes* sp. nov.**

A tall perennial with several stems from the short caudex. Stem 3-5 dm. high, slender, silky-hirsute, simple up to the inflorescence: few-leaved: basal leaves mostly 7-foliolate, digitate, with hirsute petioles, 5-15 cm. long; leaflets obovate to oblanceolate, obtuse, coarsely crenate, 2-6 cm. long, green and sparingly strigose above, white-tomentose beneath; stem-leaves similar, but smaller, usually 5-foliolate, short-petioled: stipules ovate-lanceolate, entire: cyme open: pedicels very slender, as well as the hypanthium and calyx silky hirsute and more or less viscid: bractlets linear-lanceolate, a little shorter than the lanceolate, acute sepals: petals yellow or somewhat orange, broadly obcordate or

obovate and emarginate, 6–8 mm. long, exceeding the sepals : stamens about 20.

This species is nearest related to *P. pulcherrima* Lehm., and I had referred all the specimens cited below, except the type, to that species. It differs from *P. pulcherrima* in the very slender pedicels, the total lack of tomentum on the hypanthium and the calyx and the evident viscosity of these organs and the pedicels. It grows in mountain meadows and on hillsides at an altitude of 2400–3200 m.

COLORADO : Wahatoya Cañon, Spanish Peaks, 1900, *Rydberg & Ireland*, 6039 (type) ; West Mancos Cañon, 1898, *Baker, Earle & Tracy*, 306 ; La Plata Mountains, 182.

MONTANA : Bridger Mountains, 1896, *J. H. Flodman*, 561.

***Potentilla permollis* sp. nov.**

A stout hoary perennial. Stems simple, about 6 dm. high, densely and softly pubescent with long whitish hairs : basal and lower stem-leaves usually 7-foliolate, digitate ; petioles about 1 dm. long, pubescent : leaflets obovate to oblanceolate, obtuse, coarsely cleft nearly half way to the midrib, with lanceolate lobes, densely soft-pubescent on both sides, greenish above, white and somewhat tomentose beneath : upper stem-leaves 3–5-foliolate, similar, smaller, short-petioled : stipules of the stem-leaves large, adnate to the petiole, ovate, often over 3 cm. long : cyme rather open : hypanthium and calyx densely white-pubescent : bractlets linear-lanceolate, about equalling the lanceolate sepals : petals yellow, 6–7 mm. long, obcordate, exceeding the sepals by about one fourth : stamens about 20.

This species is nearest related to *P. Blaschkeana* ; but differs principally in the denser and white pubescence and the smaller flowers. It grows in meadows.

WASHINGTON : Endicot, Whitman Co., 1898, *A. D. E. Elmer*, 1830.

***Potentilla obovatifolia* sp. nov.**

A low perennial with a thick tap-root : stems ascending or depressed, 2–3-leaved, 1.5–2 dm. high, sparingly villous : basal leaves mostly digitately 7-foliolate with petioles 3–10 cm. long : leaflets broadly obovate, obtuse, coarsely crenate-serrate, green and sparingly hairy above, white tomentose beneath, .5–3 cm. long : stem leaves mostly 3-foliolate, small, short-petioled with broadly lanceolate stipules : cymes open but few-flowered : hypanthium and calyx densely silky : bractlets and sepals lanceolate, sub-

equal : petals obcordate, yellow, about 8 mm. long, nearly twice as long as the sepals.

This species is a member of the *concinna* group and nearest related to *P. concinniformis* ; but is larger ; the leaflets are greener and more glabrous above and the bractlets are longer. By the size it approaches the *gracilis* group.

MEXICO : *Pringle*, 6890.

Potentilla Hallii sp. nov.

A more or less villous-hirsute ascending or decumbent perennial with a short rootstock or caudex : stem about 3 dm. long, sparingly villous-hirsute, terete and light green : leaves mostly digitately 5-foliolate or the upper 3-foliolate or simple : basal ones with petioles 3-5 cm. long : leaflets obovate, 1-3 cm. long, coarsely serrate-crenate, green and slightly hairy above : paler, hirsute and sparingly tomentulose beneath : upper stipules ovate, entire, 12-15 mm. long : cyme rather open : hypanthium and calyx hirsute, more or less tinged with purple : bractlets ovate-lanceolate about one third shorter than the ovate acute sepals : petals yellow, about 5 mm. long, scarcely exceeding the sepals : stamens 20.

This species is nearest related to *P. fastigiata*, but is greener and with a more open cyme. As to the pubescence of the leaves, it resembles *P. viridescens* ; but is in every respect smaller and the stem is not erect. On account of its small size, it could just as well be referred to the *maculata* group as to the *graciles*. The type grew at an altitude of about 1600 m.

CALIFORNIA : Pine Ridge, Fresno County, 1900, *Hall & Chandler*, 182.

Potentilla propinqua

Potentilla diffusa A. Gray, Mem. Am. Acad. 1849 : 41. 1849. Not Willd.

P. Hippiana, var. *diffusa* Lehm. Ind. Sem. Hort. Bot. Hamb. 1849 : 8.

P. Hippiana, var. *propinqua* Rydb. Bull. Torr. Club, 24 : 3. 1897.

The original specimens were rather depauperate and the most prominent characters which separate it from *P. Hippiana* were not noticed by me when I prepared my Monograph of the North American Potentilleae. The plant is much greener than *P. Hippiana* ; the upper surface of the leaves, as well as the pedicels,

hypanthium and the calyx, is only slightly silky, not at all tomentose; the cyme in well-developed specimens is more open and flat-topped; and the upper segments of the leaves are decurrent and sometimes confluent, which is never the case in *P. Hippiana*. By the latter characters it approaches *P. ambigens* Greene. From this it differs in the appressed pubescence, the smaller flowers and the less coarsely toothed segments. Baker's no. 390, as represented in the herbarium of the New York Botanical Garden, was named *P. ambigens* by Professor Greene, but belongs unquestionably to this species.

***Horkelia Chandleri* sp. nov.**

A low silky perennial with very thick and woody root and short cespitose caudex with erect branches densely covered by the remains of old leaves. Stems scapiform, slender, silky villous, 7-16 cm. high: basal leaves numerous, 4-5 cm. long, densely silky, terete, worm-like from the numerous small crowded segments: flowers about 4 mm. in diameter, rather many in subcapitate dense clusters, hypanthium cup-shaped, as well as the calyx densely villous: bractlets linear, about two thirds as long as the triangular-ovate sepals: petals yellow, linear, 1.5 mm. long, shorter than the sepals: stamens mostly 5: filaments subulate-filiform.

This species closely resembles *H. Muirii* in the leaves and the thick root and caudex: but differs in the taller scape, the more numerous flowers, the longer bractlets, and the narrower linear petals. The type grew at an altitude of about 3450 m.

CALIFORNIA: Mt. Goddard, 1900, *Hall & Chandler*, 700.

***Drymocallis gracilis* sp. nov.**

A tall and slender, glandular pubescent perennial with a more or less cespitose caudex. Stem about 6 dm. high, glandular-pilose throughout, branched above: basal and lower stem-leaves pinnately 7-9-foliolate, 1-3 dm. long: leaflets obovate to flabelliform, 1-5 cm. long, coarsely incised, except at the bases, sparingly pubescent on both surfaces: upper stem-leaves 3-5-foliolate, subsessile: pedicels slender, .5-4 cm. long, very glandular: hypanthium and calyx glandular: bractlets linear, about half as long as the lanceolate acuminate sepals; these in fruit often 8 mm. long: petals white, small, broadly obovate, scarcely exceeding the sepals: stamens, 20-25: style slightly fusiform.

This species resembles most *D. glandulosa incisa* in habit and

leaf-form ; but differs in the white petals, more acuminate sepals and the denser glandular pubescence. The type was collected at an altitude of about 1600 m.

CALIFORNIA : Pine Ridge, Fresno County, 1900, *Hall & Chandler*, 138.

II. SOME SPECIES FROM GREENLAND

Some time ago Mr. Morten Pedersen, Assistant at the Botanical Garden of Copenhagen, requested me to determine a collection of *Potentillae* collected by him in Greenland. He also kindly sent me several other specimens from the herbarium of the Botanical Museum of such forms that I had not seen at all or of which I had had only imperfect material. With the help of this material I have been able to settle several important points and considerably modify the disposition in my monograph.

POTENTILLA MACULATA Pourr. Act. Toloss. 3: 316. 1788

The following specimens additional to those given in my monograph,* belong to this species :

GREENLAND : Kingua Tasiusok ($61^{\circ}45'$), 1889; Scoresby Sund, 1891; Danmarks, Oe. 1892; Jameson's Land, 1891, *N. Hartz*; Godthaabs Fjord, 1883, *J. A. D. Jensen*; Alangua, 1885, *S. Hansen*; Umanaks Fjord, 1885, *P. Eberlin*; (locality not given), *Raben*, 1; Scoresby Sund, 1891, *H. Hartz*; † Kvan Valley, behind Ujaragsugsuk, 1898, *Morten Pedersen*, 705; Ekalunguit Itivnerit 429; both on Disco.

POTENTILLA MACULATA var. FIRMA Lange, Consp. Fl. Groenl. 235 is scarcely that of Lehmann,‡ although it agrees perfectly with Lehmann's description. The latter was in reality based upon *P. alpestris* a. *firma* Koch. I have no means to find what this really is; but Lehmann cites *P. alpestris* c. *rubens* Hegetschw. and *P. rubens* Vill. as synonyms. These names represent a coarser plant from Austria, Switzerland and Italy with longer and more acute teeth to the leaves. I think it is a good species distinct from

* Mem. Dep. Bot. Columbia Univ. 2: 59.

† This sheet is labeled *Potentilla maculata* Pourr. var. *gelida* C. A. Mey., as it appears on the label from the fact that a few of the basal leaves are ternate, a condition not uncommon in *P. maculata*. It has nothing to do with *P. gelida* C. A. Meyer.

‡ Rev. Pot. 120.

P. maculata. The Greenland plant cited by Lange agrees fully with the typical *P. maculata* except that the leaflets are broader, more round and overlapping each other by the margins. I scarcely think that it deserves a varietal name. If it does it must bear some other name than *firma*, as this is preoccupied. The specimens cited by Lange and the only one seen is the following:

GREENLAND: Holsteinsborg, 1884, *Eng. Warming & Th. Holm*.

Potentilla Langeana sp. nov.

P. maculata β *hirta* Lange, Conspect. Fl. Groenl. 6. 1880. Not *P. hirta* L.

A caespitose perennial. Stems erect or ascending, 2-3 dm. high, sparingly hirsute with erect branches: basal leaves digitately 5-foliolate: stipules large, adnate, lanceolate, 1-2 cm. long: petioles 3-8 cm. long, sparingly hirsute: leaflets cuneate-obovate, more or less densely silky-hirsute on both sides, 1-3 cm. long, coarsely toothed above the middle with oblong ovate teeth, the cuneate base entire: lower stem leaves similar but smaller and short-petioled: upper stem-leaves ternate or simple and subsessile: stipules ovate, acutish, about 1 cm. long: cyme 3-7-flowered: hypanthium silky hirsute: bractlets oblong to lanceolate, acute or obtuse, about one fourth shorter than the lanceolate sepals: petals broadly obcordate, 7-8 mm. long: stamens about 20.

The species differs from *P. maculata* not only in the characters given by Lange, the several-flowered cymes and the long pubescence of the leaves; but also in the more acute teeth, the longer and more acutish bractlets and narrower sepals. In *P. maculata* both the teeth of the leaves and the bractlets are rounded at the apex and the latter are only one half or two thirds as long as the sepals. *P. Langeana* is in reality nearer related to *P. verna* than to *P. maculata* but distinguished from that by the pubescence. In Conspectus Florae Groenlandicae several more specimens are cited belonging to *P. maculata* β *hirta* Lange. The following are the only ones seen by me:

GREENLAND: Amaralik Fjord, 1831, *J. Vahl* (type); Kangerdluarsuk Fjord, 1884, *Warming & Hohn*; Natsilik, *S. Hanson*; Ekalunguit Itivnerit on Disco, 1898, *Morten Pedersen*, 419; Ekgitok in Disco Fjord, 1684 (a taller and more glabrate form*);

* This was labeled *P. maculata* var. *pyrenaica* (Ramond) Lehm., which is quite a different plant, having thick leaves with short teeth directed forward.

Kuanersuit on Disco, 2710 ; Engelskmandens Havn, Disco, 1879 (a slender depauperate form *).

POTENTILLA EMARGINATA Pursh, Fl. Am. Sept. 353. 1814

Undeveloped or depauperate specimens of this species resemble often very closely *P. nana* and I am now inclined to regard the two species as forms of one. In Alaska and other arctic regions of the American Continent they seem distinct enough but the plants from Greenland, Spitzbergen and Novaja Semlja are often so confusing that it is hard to tell to which to refer them.

The specimens collected by Mr. Pedersen are as follows, those approaching *P. nana* are marked by (?).

GREENLAND : Skarvefjord, 1898, *Pedersen*, 279 ; Ingigsok, 218a and 218b ; Mudderbugten, 966 (?) ; Ekalunguit Itivnerit, 1414 ; Plateau behind Ujaragsugsak, 3099 ; all on Disco.

POTENTILLA NANA Willd.; Schlecht. Mag. Ges. Naturf. Fr. Berlin.
7 : 296. 1813

Among the many species of *P. emarginata* sent from Copenhagen, there are two sheets, however, that represent the typical *P. nana* with its round teeth and rounded obtuse sepals and bractlets, viz.:

GREENLAND : Manatsook, 1883, *Dr. Berlin* ; Upernaviarsur, 1887, *Ryder*, 7.†

POTENTILLA NIVEA L. Sp. Pl. 499. 1753

Of the typical *P. nivea* the collection sent contains many sheets, the following was the only one collected by Mr. Pedersen :

GREENLAND : Rocks behind Kuanersuit on Disco, 1898, *M. Pedersen*, 2706.

* On the label is written "*Potentilla maculata* Pourr. var. *debilis* Lehm. in var. *hirtum* Lge. transiens." Lehmann cites under the var. *debilis*, *P. incisa* Desf. as a synonym. The latter is figured in Nestler's Monograph as a large plant with narrowly cuneate leaflets deeply incised at the apex, and quite unlike the specimens cited above. The latter I cannot distinguish from the typical *P. Langeana* except in size.

† The last was determined by Lange as *P. nivea prostrata*, which must be a mistake as it is unlike the other specimen collected by Vahl and does not agree with the description.

POTENTILLA NIVEA ALTAICA (Bunge) Rydb. Mem. Dep. Bot. Columbia Uni. 2: 86. 1898

Potentilla nivea var. *arenosa* Lange Consp. Fl. Gr. 236. Not Turcz.

The specimens collected by Warming and Holm were determined by Lange as *P. nivea arenosa* Turcz. but that variety is described as having glomerate flowers, which is not the case in Warming and Holm's specimens. These do not differ from the common form of *P. nivea Altaica* except that the flowers are somewhat smaller. In fact they are as like the figure in Ledeb. Icon. Fl. Ross. 4: 329 as I have seen. If Lange's determination in this case were correct the varieties *Altaica* and *arenosa* must be united. I think, however, that the latter is quite different and restricted to Asia. The following specimens belong here and are not recorded in Conspectus Florae Groenlandicae:

GREENLAND: Amaralik Fjord, 1831, *J. Vahl*; Scoresby Sound, 1892, *N. Hartz*; Kakatsiak, 1885, *S. Hanson*; Christianshaab, 1884, *Warming & Holm*; rocks behind Kuanersuit on Disco, 1898, *M. Pedersen* 2702-5, 2707-9 (?);* Christianshaab, 1833, *J. Vahl* (?).†

POTENTILLA NIVEA PALLIDIOR Sw. Sum. Veg. Scand. 19. 1874

Potentilla nivea subviridis Ledeb. Fl. Ross. 2: 57. 1844.

The following specimens belong here:

GREENLAND: Scoresby Sound, 1892, *N. Hartz*; Godhavn, 1871, *Th. Fries*.

Potentilla subquinata (Lange)

Potentilla nivea pentaphylla Lehm. Nov. Stirp. Pug. 9: 69. 1851. Not *P. pentaphylla* Richt. 1815; *P. nivea subquinata* Lange, Consp. Fl. Groenl. 9. 1880; *P. nivea quinquefolia* Rydb.

* All of Mr. Pedersen's specimens are sterile and without fully developed leaves. They are remarkable for their long branching caudices and may belong to the variety of the next species described below or perhaps to an undescribed species. They cannot be determined satisfactorily.

† This was determined by Lange as var. *prostrata* but it does not agree with Rottboell's description especially as to the glomerate heads, sinuate-dentate leaves, revolute margins and purple veins. I refer this doubtfully here as it differs from all other specimens seen in the narrow leaflets.

Bull. Torr. Club, **23**: 302. 1896; *P. quinquefolia* Rydb. Mem. Dep. Bot. Columbia Univ. **2**: 76. 1898.

When I changed *P. nivea pentaphylla* Lehm. to *P. nivea quinquefolia*, I did not know that it was identical with Lange's var. *subquinata*. From his description, especially from the words "elegantior pinnatifidis" I was led to the supposition that it represented the quinate form of var. *Altaica*. Consequently I referred Lange's var. *subquinata* to that variety. As Lange's name is older than my own, it should be adopted. I am well satisfied with the change, as my own as a specific name is a misnomer. The following specimens belong here.

GREENLAND: Disco Fjord, 1894, *P. Sorensen*, 301; Akingdlek, 1890, *N. Hartz*, 1; Kingua Orpiksuit, 2; Atanekrdluk and Kuanersuit on Disco, 1871, *Th. Fries*; Kingigtok, 1890; *N. Hartz*; rocks behind Kuanersuit on Disco, 1898, *M. Pedersen*, 2718, 2717, 2713, 2715a, 2712; Disco Fjord, 3906; Skansen, Disco, 927; Kuganguak Valley, 2313 and 496; Vajat-shore, Unartuarsuk, 113.

SPITZBERGEN: Kap Thorsen, 1896, *E. Joergensen*.

Potentilla subquinata Pedersenii var. nov.

Caudex with elongated branches covered by the remains of old leaves; stems low, less than 1 dm. high, 1-3-flowered, as well as the petioles covered with long white hairs: leaflets small, 1-1.5 cm. long, broadly obovate; white silky on both sides and tomentose beneath, in age more glabrate above, bractlets very narrow, linear or linear-lanceolate.

GREENLAND: Vaigat Assuk, Disco, 1898, *M. Pedersen*, 470 (type) and 1061a. Rocks behind Kuanersuit, 2711, 2714, 2716, and 2710; Ingigsak, 233; Rocks by Mudderbugten, 967; Mungarut, 924; all on Disco.

POTENTILLA VAHLIANA Lehm. Mon. Pot. 29 and 172. 1820

Fine specimens of this species were also in Pedersen's collection.

GREENLAND: Vaigat, Assuk on Disco, *M. Pedersen* 1061b. Lyngmarken by Godhaven, 80; Rocks behind Kuanersuit on Disco, 2715b; Roede Elv, Disco, 3441b.

POTENTILLA PULCHELLA R. Br. in Ross' Voy. 142

GREENLAND : Kugsinarsuk, Disco, 1898, *M. Pedersen*, 494 ;
Vaigat-shore, Assuk, 457 and 941 ; Kutdlisat, 396a ; Jameson's
Land, 1891, *N. Hartz*.

POTENTILLA PULCHELLA ELATIOR Lange Consp. Fl. Groenl.

4. 1880

GREENLAND : Kardlunguak, 1890, *N. Hartz* ; Atanekerdruk,
1871, *Th. M. Fries* ; Vaigat Shore by Assuk, 1898, *M. Pedersen*,
462.

ARGENTINA ËGEDII (Wormskj) Rydb. Mem. Dep. Bot. Colum-
bia Uni. 2 : 158. 1898

GREENLAND : Disco Fjord by Kuanersuit, 1898, *M. Pedersen*,
1448 ; Ungorsivik by Maligiak, 438.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 14

STUDIES ON THE ROCKY MOUNTAIN
FLORA—V.

BY P. A. RYDBERG

NEW YORK
1901

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Studies on the Rocky Mountain Flora.—V.

By P. A. RYDBERG

Sporobolus aristatus sp. nov.

Vilfa depauperata var. *filiformis* Wats. King's Exp. 5 : 376, in part (as to the awned form). 1871. Not Thurb.

Perennial with short branching rootstock. Culm usually only 4–6 cm. high : internodes short, usually covered by the open strongly striate sheath ; ligules lanceolate, acute, about 1.5 mm. long : leaf-blades 8–14 mm. long, and about 1 mm. wide, striate and puberulent on the upper surface : panicle few-flowered, very narrow, with short erect branches ; empty glumes almost equal, or the inner slightly longer, 1–1.25 mm. long, less than half as long as the flowering glume, ovate, acutish or obtuse and somewhat erose at the apex : flowering glume about 2.5 mm. long, strongly veined, long-strigose on the veins and tipped with an awn .5–1 mm. long ; palea almost equal to the flowering glume (awn excepted) in length, acuminate, but not awned, strigose.

This species is closely related to *S. filiformis* (Thurb.) Rydb. differing in the lower habit, less exserted panicle, firmer empty glumes and the presence of a distinct awn. It grows in wet places at an altitude of 2000–2500 m.

WYOMING : Big Horn Mountains, Sheridan Co., 1899, *F. Tweedy*, 2196 (type) ; Spread Creek, 1897, 27.

UTAH : Bear River Cañon, 1869, *S. Watson*, 1281.

Poa platyphylla Nash & Rydb.

Poa trivialis var. *occidentalis* Vasey, Desc. Cat. Grasses 85. 1885. Not *Poa flexuosa* var. *occidentalis* Vasey. 1878.

Poa occidentalis Vasey, Cont. U. S. Nat. Herb. 1 : 275. 1893.

Carex ebenea sp. nov.

Perennial by a cespitose rootstock. Stem 2–4 dm. high, strongly striate ; sheath with a conspicuous membranaceous ligular portion, ligule proper rounded, about 2 mm. long ; leaf-blades flat, 1–2 dm. long, 3–6 mm. broad, strongly nerved : spikelets about 1 cm. long in a dense globular or rounded-conical head :

shining, brownish black with a lighter midrib, lanceolate, acute, 3-4 mm. long: perigynia lanceolate, tapering gradually into a long beak, with the beak about 5 mm. long, dark brown; staminate flowers at the base and mixed with the pistillate: upper portion of the wings and the beak scabrous on the margins; teeth at the apex of the beak very short, subulate: styles 2: achene oblong, lenticular, nearly 2 mm. long and fully 1 mm. broad.

This species is nearest related to *C. festiva* and has been labeled *C. festiva Haydeniana*, but it is not the same as the original of that variety, which has broadly ovate perigynia. *C. chenca* differs also from all forms of *C. festiva* in the form of the perigynia and in the dark glossy color of the bracts and perigynia.

COLORADO: Pikes Peak, 1900, *F. Clements* (type); Windy Point, 1900; Mt. Harvard, 1896, 7; Grecian Bend, 1896, Bottomless Pit, and Saddle, *Clements*; between Cheyenne Mountain and Seven Lakes, 1896, *E. A. Bessy*; Iron-ton, 1899, *C. C. Curtis*; Telluride, 1894, *F. Tweedy*, 194; Chambers Lake and Cameron Pass, 1896, *C. F. Baker*; Clear Creek Cañon, 1878, *M. E. Jones*, 267; Silver Plume, 1895, *Rydberg*, 2460; Pagosa Peak, 1899, *C. F. Baker*, 233.

***Streptopus curvipes* Vail sp. nov.**

Simple, glabrous, except the margins of the leaves and the peduncles. Stems 1-3 dm. high, from a slender rootstock covered with few fibrous rootlets: leaves sessile, oval or oblong-lanceolate, 3-8 cm. long, acuminate at the apex, rounded and slightly clasping at the base, 3-5-nerved, the margins finely glandular-ciliate: flowers 3-5, solitary: peduncles not geniculate, 5-15 mm. long, glandular-pubescent: flowers pale purple or rose-colored: perianth-segments lanceolate, 5-7 mm. long, minutely glandular-pubescent on the inner surface: anthers 2-beaked; beaks slender, about half the length of the anther: style 3-cleft, the spreading branches stigmatic along the inner side: berry globose, when mature brick red, 7-9 mm. in diameter: seeds clavate, 3-4 mm. long, with many cross-striate ridges.

Differs from *Streptopus roseus* in its simple habit and the non-geniculate and much shorter peduncles. The beaks of the anthers seem to be a trifle longer than in *S. roseus*. It is closely related to *S. brevipes* Baker, but is larger and coarser in every respect. The flowers of the latter species are not known.

BRITISH COLUMBIA: Asulkan Pass, alt. 4400 ft., June to July,

1897, *Mrs. Zoë W. Palmer* (type); Glacier, alt. 4122 ft., June to July, 1897, *Mrs. Zoë W. Palmer*; Glacier, June, 1897, *Mr. & Mrs. Cornelius Van Brunt*.

ALASKA: Juneau, along the mountain side, July 24, 1891, *Miss Grace E. Cooley*; Yes Bay, July 10, 1895, *Thomas Howell*, 1664 (all in Herb. N. Y. Botanical Garden or Columbia University); *Ferd. Bishoff*.

OREGON: *E. Hall*, 521.

WASHINGTON: Skamania Co., Aug., 1886, *Suksdorf*; Mt. Adams, 3-400 ft., *Suksdorf*, 44; June, 1879, *J. Howell* (the last five specimens in Herb. Gray).

***Vagnera brachypetala* sp. nov.**

A tall stout perennial, 5-8 dm. high. Stem striate, puberulent, especially the upper portion: leaves subsessile or short-petioled, oval or ovate, 8-18 cm. long, 4-7 cm. wide, often short-acuminate and twisted at the apex, with 5-7 stronger nerves and numerous weaker ones: panicle on a peduncle 4-5 cm. long, rather dense, 3-10 cm. long and 2-5 cm. broad: petals and sepals oblong, 1-1.5 mm. long, scarcely half as long as the broadly dilated, lanceolate-subulate petaloid filaments: style about .5 mm. long: berry dark purple, about 6 mm. in diameter.

This species is closely related to *V. racemosa* and *V. amplexicaulis*, perhaps most nearly to the former, but is easily distinguished by the short petals and the purple fruit. In *V. racemosa* the petals and sepals are almost as long as the filaments and the fruit is 7-8 mm. in diameter and red with purple spots. *V. brachypetala* grows on hillsides up to an altitude of 2500 m.

BRITISH COLUMBIA: Glacier, at the "Loup," 1897, *Mr. & Mrs. Cornelius Van Brunt* (in fruit, type); Deer Park, Columbia River, 1890, *John Macoun*; Victoria, Vancouver Island, 1893, *John Macoun*, 5998.

WASHINGTON: Seattle, 1891, *C. V. Piper*, 198.

IDAHO: Lake Waha, 1892, *Sandberg*, *MacDougal & Heller*, 228.

***Vagnera leptopetala* sp. nov.**

A slender glabrous perennial, 2-3 dm. high. Rootstock very slender for the genus, white, only about 2 mm. in diameter: stem erect, strict or the upper portion somewhat zigzag, striate and pale: leaves oblong-lanceolate, 6-8 cm. long, 1-2 cm. wide, light

green, sessile, long-acute, with 3-5 stronger nerves and 12-14 weaker ones: raceme terminal, simple, 3-6-flowered: pedicels 5-8 mm. long: petals and sepals linear, acute, about 4 mm. long and less than 1 mm. wide, very thin, white: fruit not seen.

This species is nearly related to *V. stellata* and *V. liliacea*, but differs in the narrow petals and sepals, the slender rootstock and the lighter green foliage. It grows in rich soil in cañons at an altitude of 2000-2100 m.

COLORADO: Headquarters of Sangre de Christo Creek, 1900, *Rydberg & Vreeland*, 6441 (type); Dark Cañon, Pikes Peak, 1900, *Fred Clements*.

***Limnorchis purpurascens* sp. nov.**

A rather stout plant, 3-5 dm. high, with fleshy-fibrous roots. Leaves ovate to lanceolate, acute, 6-10 cm. long, 1.5-3 cm. wide, dark green: bracts lanceolate, the lower exceeding the flowers: spike rather dense: flowers 10-12 mm. long: lateral sepals green, oblong-linear, or linear, obtuse, 4-5 mm. long; the upper sepal tinged with purple, broadly ovate, erect, obtuse: petals slightly shorter, erect, purple, lanceolate, oblique: lip broadly linear-lanceolate, about 5 mm. long, purplish, scarcely at all dilated at the base, the edges almost straight: spur scarcely more than half as long as the lip, much thickened and saccate.

This species belongs to the *L. hyperborea* group, and is perhaps nearest related to that species. It differs, however, in the purple petals and lip and the shorter and more saccate spur. The spur has almost the same form as that of *L. stricta*; but from that species it differs in the dense spike and the broader lip. *L. purpurascens* grows in damp woods at an altitude of 2700-3000 m.

COLORADO: Iron Mountain, 1900, *Rydberg & Vreeland*, 6444 (type); Manitou, 1900, *Fred Clements*, 172; Georgetown, 1878, *M. E. Jones*, 314.

***Piperia* gen. nov.**

Montolivaca Rydb. Mem. N. Y. Bot. Gard. 1: 106. 1900. Not Reichenb.

Professor C. V. Piper of the Agricultural Experiment Station at Pullman, Washington, has called my attention to the fact that the genus *Montolivaca* was based not on *Platanthera elegans* Lindley, or *Habenaria elegans* Bolander; but on *Montolivaca elegans* Reich-

enb., or *Habenaria elegans* Jackson, of a much later date. The genus that I shortly characterized under the name of *Montolivaca* in the Memoir cited above, is therefore without a name. As I find that no genus has at yet been dedicated to Professor Piper, I take the pleasure in naming this for him. The genus contains at least three species, viz.

***Piperia elegans* (Lindl.)**

Platanthera elegans Lindl. Gen. & Sp. Orch. 285. 1835.

Habenaria elegans Boland.; Wats. Bot. Calif. 2: 133. 1876.

Montolivaca elegans Rydb. Mem. N. Y. Bot. Gard. 1: 106. 1900. Not Reichenb.

***Piperia Unalaschensis* (Spreng.)**

Spiranthes Unalaschensis Spreng. Syst. 3: 708. 1826.

Habenaria Unalaschensis Wats. Proc. Am. Acad. 12: 277. 1876.

Montolivaca Unalaschensis Rydb. Mem. N. Y. Bot. Gard. 1: 107. 1900.

***Piperia elongata* sp. nov.**

A slender strict plant, 4-7 dm. high. Corm ellipsoid, about 2 cm. long and 1 cm. in diameter: leaves 2, near the base; blades lanceolate or oblanceolate, acute, 8-15 cm. long, 1-2 cm. wide: spike elongated and lax, 2-3 dm. long: flowers about 1 cm. long: sepals green, about 5 mm. long, the upper lanceolate, the other two linear obtuse: petals lanceolate, oblique, equalling the sepals: lip entire, broadly lanceolate: spur slender, scarcely clavate, almost cylindrical, arcuate, 10-12 mm. long, about .7 mm. thick.

This is somewhat intermediate between the two preceding. It has almost the same flowers as the first and the general habit of the second. *P. elegans*, with which it has generally been confused, has a stouter, more fleshy stem, thicker bracts and a short crowded spike. *P. Unalaschensis* has the same habit as the present species, but the spur is very short and saccate. *P. elongata* grows in open woods, up to an altitude of 700 m.

IDAHO: Priest Lake, near lower end, 1900, *D. T. MacDougal*, 168 (type); Priest River Valley, 134.

WASHINGTON: W. Klickitat County, 1885, *W. N. Suksdorf*; Seattle, 1889, *C. V. Piper*, 1081.

Corallorrhiza Vreelandii sp. nov.

Scape rather stout, 2-4 dm. high, dark purplish brown. Sheaths, especially the lowest one, much inflated, purplish brown with dark purple striations: flowers 6-15, about 15 mm. long, in fruit drooping: sepals oblong, 7-8 mm. long, brown with 3 purple stripes: petals similar but slightly broader and with 4 stripes: lip ovate, entire, with a small gibbosity at the base: spur none.

This is nearest related to *C. striata*, from which it differs in the smaller flowers and narrower sepals and petals. The type was found growing among alders and willows at the margin of a small lake, at an altitude of about 2700 m. It was first discovered by Mr. F. K. Vreeland, my enthusiastic associate and pleasant companion in field work last summer.

COLORADO: Veta Mountain, 1900, *Rydberg & Vreeland*, 6418.

Salix Wyomingensis sp. nov.

A shrub 1 m. high or less. Bark of the main trunk gray; that of the branches dark-brown or grayish, shining, somewhat flaky; young branches appressed-villous; buds brown, shining, pubescent when young: leaves small, rather crowded; petioles 2-4 mm. long; blade oval or obovate, acute, 1-3 cm. long, entire or exceedingly minutely callous-denticulate, upper surface green and shining, slightly pubescent when young, glabrate in age; lower surface pale bluish green, appressed silky-villous: aments borne on very short leafy branches, about 3 cm. long, 8-10 mm. in diameter: bracts brown, oblong or ovate, obtuse: pedicels scarcely 1 mm. long: ovary villous, but green, when fully developed only about 3 mm. long: style .5 mm. long: stigmas short, slightly 2-cleft.

This species is nearest related to *S. glaucops* Anderson, but differs in the small oval or obovate leaves and the much smaller and greener ovaries. It grows at an altitude of 2100-2700 m.

WYOMING: Eastern Slope of Big Horn Mountains, headwaters of Clear Creek and Crazy Woman River, 1900, *F. Tweedy*, 3434 (type) and 3433.

Salix stenophylla sp. nov.

A shrub 2-5 m. high. Bark of older stems light brownish green, smooth; that of the slender strict branches brown: young shoots silvery pubescent: leaves narrowly linear, 3-7 cm. long, about 3 mm. wide, acute, entire or minutely and distantly denticulate, permanently finely silky strigose, but not white: pistillate

aments 3-4 cm. long at the ends of short leafy branches: bracts yellow, oblanceolate, deciduous, acute, 2-2.5 mm. long, rather sparingly silky-villous: pistil green, about 4 mm. long, glabrous except the swollen portion at the end just below the red stigma: stipe about 1 mm. long: style none: stigma minutely 4-lobed: fruit glabrous, narrowly ovoid-conic, about 6 mm. long, and 1.5 mm. in diameter: staminate aments 2-3 cm. long, 5 mm. in diameter: bracts like those of the pistillate aments, but more obtuse and more villous: stamens 2, about twice as long as the bracts: filaments slightly hairy, especially below.

This species is a member of the *longifolia* group and nearest related to *S. exigua* Nutt., at least as understood by Professor Rowlee; but differs in the narrower leaves, the distinct stipe and the peculiar swelling just below the stigma. It grows on river banks up to an altitude of 2500 m.

COLORADO: Cuchara River, below La Veta, 1900, *Rydberg & Ireland*, 6392 (staminate flowers) and 6393 (pistillate, type); Mancos, 1898, *Baker, Earle & Tracy*, 127 (staminate) and 102 (pistillate in fruit).

NEW MEXICO: 1851-2, *Wright*, 1874 and 1875; 1847, *Fendler*, 813.

ARIZONA: San Francisco Mountains, 1881, *Rusby*, 371.

***Salix padifolia* sp. nov.**

A shrub 1-7 m. high, with light brown smooth bark. Young twigs strict, glabrous and shining, yellow, or often brown or purple: stipules ovate or rounded, glandular-dentate: leaves with petioles 5-8 mm. long; blade oval or broadly elliptic, crenate, short-acute or obtusish, rounded at the base, 3-5 cm. long, 1.5-2 cm. wide, when young sparingly covered with silky hairs, but soon glabrate, dark green above, paler beneath: pistillate aments 3-4 cm. long, densely flowered, appearing usually before the leaves, borne on very short branches and subtended by 1-4 small leaves: bracts obovate, fuscous, covered on the outside with white wool: pistils nearly sessile, glabrous: style about 1.5 mm. long: stigmas 2, nearly 1 mm. long, 2-cleft: capsules ovate-conic, about 6 mm. long: staminate aments almost sessile, 2-3 cm. long, 10-12 mm. in diameter: bracts as those of the pistillate aments: stamens 2; filaments glabrous.

This is a species of the *cordata* group and nearest related to *S. Mackenziana*; but differs in the shorter oval leaves, the shorter and thicker aments and the exceedingly short stipes. It has gen-

erally been referred to *S. cordata*; but has much thicker and shorter aments and the leaves are quite different, thin, very short and broad, never acuminate and never sharply serrate. It grows along streams at an altitude of 2000-3000 m.

COLORADO: Tributaries of Turkey Creek, 1900, *Rydberg & Ireland*, 6389 (fruit, type); Ojo, 6386 (staminate) and 6387 (pistillate); Pass Creek, 6388 (pistillate); Los Pinos, 1899, *Baker*, 271; Bob Creek, 1898, *Baker, Earle & Tracy*, 175; Silverton, 1895, *F. Tweedy*, 268 (?).

WYOMING: Golden Gate, 1899, *Aven & Elias Nelson*, 5549.

MONTANA: Ten miles east of Monida, 1899, *Aven & Elias Nelson*, 5427.

***Salix flava* sp. nov.**

A shrub or small tree, 4-7 m. high, with grayish yellow rough bark. Branches short and divergent, light yellow, smooth and shining: stipules rounded, entire: leaves with petioles 2-6 mm. long; blades lanceolate, short-acuminate or acute, entire or indistinctly crenulate, rather firm, yellowish green, glabrous on both sides, 3-7 cm. long: pistillate aments 2-3 cm. long, almost sessile, subtended by 1-2 leaves or naked: bracts very short, obovate, fuscous, densely long-woolly: pistil stipitate, glabrous: stipe in fruit often 2 mm. long: style about .5 mm. long: stigmas oblong, subentire: capsule ovate, about 6 mm. long: staminate aments 2-3 cm. long, sessile: bracts as in the pistillate aments: stamens 2; filaments glabrous.

This is also a member of the *cordata* group and nearest related to *S. lutea* Nutt., differing in the less acuminate and subentire leaves, which are not paler beneath, and the longer stipes. It grows along streams at an altitude of 1500-2000 m.

WYOMING: Green River, 1895, *Rydberg* (type); Spread Creek, 1897, *F. Tweedy*, 302.

MONTANA: Boulder River, 1888, *F. Tweedy*, 63.

IDAHO: Beaver Cañon, 1895, *Rydberg*.

NEVADA: Unionville, 1868, *S. Watson*, 1097.

UTAH: Wahsatch Mountains, 1869, *S. Watson*, 1096, in part.

COLORADO: South Park, 1873, *J. Wolfe*; Cucharas Valley, near La Veta, 1900, *Rydberg & Ireland*, 6377; Manitou, 1878, *M. E. Jones*, 30.

***Blitum hastatum* sp. nov.**

A slender annual, 2-4 dm. high. Leaves very thin; blades

3-7 cm. long, ovate or ovate-lanceolate in outline, but often hastately lobed at the base, which is broadly cuneate and decurrent on the slender petiole; the upper ones smaller and generally not hastate: lower petioles 2-4 cm. long; flowers in small glomerules in the upper axils and on a slender interrupted terminal spike: seeds brownish black, smooth and shining, about 1 mm. long.

This species differs from *B. capitatum* in the hastate or entire, never toothed, thin leaves and in the inflorescence which is more inclined to be naked above, more lax and with smaller glomerules. It grows at an altitude of 2000-3000 m.

WYOMING: Buffalo, 1900, *F. Tweedy*, 3295 (type).

UTAH: Alta, Wahsatch Mountains, 1879, *M. E. Jones*, 1181.

NEVADA: Above Thousand Springs Valley, 1868, *S. Watson*, 977.

***Alsine Curtisii* sp. nov.**

Slender, erect, branched, 2-6 dm. high with a slender horizontal rootstock. Stem sharply 4-angled, glabrous, except at the inflorescence: leaves linear or lance-linear strongly 1-nerved, sessile, rounded and half clasping at the base, long-attenuate at the apex, 3-6 cm. long, 3-5 mm. wide, those of the inflorescence smaller: branches of the many-flowered cymes divergent, very viscid-pubescent: sepals about 3 mm. long, thick, ovate-oblong, obtuse or acutish with a narrow white margin: petals about 7 mm. long, cuneate with a broad and deep sinus at the apex: seeds very few, dark brown, almost 2 mm. in diameter.

This species is nearest related to *A. Jamesii* and has been confused with it; the differences are mostly in the leaves and sepals. In *A. Curtisii* the former are scarcely half as wide as those of *A. Jamesii*, and the sepals of the former are rather thick while in the latter almost membranous. *A. Curtisii* grows at an altitude of 1800 to 3000 m.

WYOMING: Headwaters of Cliff Creek, 1900, *C. C. Curtis* (type).

UTAH: Wahsatch Mountains, 1869, *S. Watson*, 159 (in part); Beaver Valley, 1877, *E. Palmer*, 51½; Alta, Wahsatch Mountains, 1879, *M. E. Jones*, 1160.

NEVADA: East Humboldt Mountains, 1868, *S. Watson*, 159 (in part).

ARIZONA: Mogallon Mountains, 1881, *H. H. Rusby*.

***Arenaria confusa* sp. nov.**

A slender diffuse plant with caespitose, perennial, but not ligneous base. Stems slender, branched, 4–6 dm. long, finely puberulent: leaves opposite, linear-lanceolate, pointed, with a strong midrib, puberulent, 1–2 cm. long: pedicels in fruit divergent, about 1 cm. long, slightly bent under the calyx: sepals linear-lanceolate, acuminate, scarious-margined, not tuberculate-punctate, about 3 mm. long: petals about three fourths as long as the sepals: capsule broadly ovoid, about 4 mm. long.

This species is related to *A. lanuginosa* and *A. saxosa*, and somewhat intermediate between the two. In habit it resembles most the former, but does not have the subverticillate or fascicled leaves; the sepals are narrowly lanceolate instead of ovate and not tuberculate-punctate, the stem is not retrorsely pubescent as in that species and the petals are larger. In all specimens of *A. lanuginosa* seen by me the petals are either lacking or not more than half as long as the sepals. *A. saxosa* is subligneous at the base, has low stems, short leaves, mostly less than 1 cm. long and sepals even in flower 4–5 mm. long. Dr. B. L. Robinson, in the Synoptical Flora, remarks under *A. alsinoides* (*A. lanuginosa*): "A more western form, represented from New Mexico by Fendler's 58 and 62 and Wright's 864, has slightly firmer stems, more numerous subpaniculate flowers, and leaves less narrowed at the base. In all these respects it shows a transition to the following." I have not seen the numbers of Fendler's collection cited; but Wright's 864 as represented in Columbia University Herbarium belongs to *A. confusa*. On the sheet of Rusby's 38, cited below, found in the Columbia University herbarium, Dr. Robinson has written in pencil: "Apparently this is merely a lax form of *A. saxosa* Gray. The earliest leaves are crowded, the upper internodes much elongated, and later flowers are always smaller. (B. L. R.)" Wilcox's plant cited below was also determined by Dr. Robinson as *A. saxosa*. Both of these agree perfectly, however, with Wright's specimens; but neither with our material of *A. lanuginosa* from the Southern States and Mexico, nor with the type of *A. saxosa*. *A. confusa* grows in cañons at an altitude of 2000–3500 m.

NEW MEXICO: White Mountains, 1897, *E. O. Wootton*, 295 (type); 1851, *C. Wright*, 864; Burrow Mountains, 1880, *H. H. Rusby*, 38.

ARIZONA: Ft. Huachuca, 1892, *T. E. Wilcox*; Rincon Mountains, 1891, *Neally*, 119; Flagstaff, 1894, *J. W. Toumey*.

COLORADO: La Plata Mountains, 1896, *F. Tweedy*, 426; Wahatoya Creek, 1900, *Rydberg & Vreeland*, 6274; Pagosa Peak, 1899, *C. F. Baker*, 309.

***Delphinium ramosum* sp. nov.**

A tall perennial, often 2 m. high. Stem glabrous and shining up to the inflorescence, often tinged purplish or bluish: petioles 1-1.5 dm. long; leaf-blade glabrous above, finely puberulent beneath, divided near the base into 5-7 segments, which are 4-7 cm. long, oblanceolate or obovate, cuneate in outline, unequally 3-cleft and these segments again cleft into oblong or lanceolate lobes 3-6 mm. broad: inflorescence with slender branches, these sparingly and finely puberulent: bracts linear-subulate, 5-10 mm. long: pedicels slender, 1-3 cm. long: bractlets filiform, 2-5 mm. long, inserted 2-5 mm. below the calyx: sepals dark blue, striately nerved, slightly brownish at the base, about 1 cm. long, ovate; the upper and lower ones acute; the lateral ones obtuse, all puberulent: spur about 1 cm. long, straight, or slightly curved at the apex: upper petals dirty-white, tinged with brown and blue, about 8 mm. long: spur slender, almost 1 cm. long: lateral petals dark blue, bearded, with a slender claw, somewhat corniculate, bent at right angles and only slightly 2-lobed at the apex: follicles 3, 12-15 mm. long, somewhat spreading and with divaricate beaks.

This species has without doubt been included in *D. scopulorum*, but is evidently distinct from the type of that species. It is taller, with more branched inflorescence, glabrous stem and the flowers are usually tinged with brown at the base. The type of *D. scopulorum* has narrow, very acute and divergent lobes of the leaves and the calyx is purely dark blue. *D. ramosum* grows at an altitude of 2000-3000 m.

COLORADO: North Cheyenne Cañon, 1896, *E. A. Bessey* (type); also in Williams Cañon, Artists Glen and other places near Pikes Peak; "Colorado," 1889, *Alice Eastwood*.

***Delphinium robustum* sp. nov.**

A tall and stout perennial, often 2 m. high or more. Stem leafy, striate, puberulent throughout, often 1 cm. in diameter at the base; petioles 1-2 dm. long, puberulent; leaf-blade finely and

sparingly puberulent on both sides, divided to the base into 5-7 segments, which are 6-12 cm. long and twice cleft into linear lobes 3-5 mm. broad: inflorescence branched, densely many-flowered: pedicels 1-3 cm. long, rather stout, usually equalled or surpassed by the linear bracts: bractlets filiform, 5-10 mm. long, inserted close under the calyx: sepals dark blue, paler at the base, elliptical, all except the upper one obtuse, 12-15 mm. long; spur 12 mm. long, slightly curved: upper petals narrow, light brownish, striate: lateral petals with slender claws bent at right angles, bearded only within, deeply 2-cleft at the apex.

This species in perhaps closest related to *D. cucullatum* A. Nelson but differs in the longer and narrower leaf-segments, the more branched inflorescence, the stouter habit, the longer bracts and bractlets and narrower upper petals. It grows at an altitude of about 2500 m.

COLORADO: Wahatoya Creek, below the Spanish Peaks, 1900, Rydberg & Ireland, 6217 (type); Colorado Springs, 1895, E. A. Bessey; Ruton, 1840, Albert.

Erysimum alpestre (Cockerell)

Erysimum asperum f. *alpestre* Cockerell, Bull. Torr. Club, 18: 168. 1891.

A tall strigose perennial with a deep tap-root: stem strict, simple, 3-6 dm. high, striate: basal leaves linear or narrowly linear-oblongate, 5-10 cm. long, 2-7 mm. wide, subentire or sinuately denticulate, grayish strigose, gradually tapering below with a short petiole: stem leaves mostly narrowly linear, the upper sessile: raceme at first short and corymbiform, in fruit much elongated: pedicels short, in fruit scarcely 1 cm. long, ascending: calyx 10-12 mm. long, yellow: two of the sepals strongly saccate at the base: petals with slender claws: blades broadly obovate-cuneate, slightly emarginate, about 8 mm. long and broad, varying from orange or brown to rose-purple or the older pale yellow: pods four-angled, slender, erect, 7-8 cm. long and 1.5 mm. in diameter: style about 2 mm. long, stout.

In general habit, this species closely resembles *E. asperum*. Mr. Cockerell, who seems to have been the first to observe this interesting plant of the Sangre de Cristo region, took it to be a form of *E. asperum* with peculiarly colored petals, found only at high altitudes. I was first of the same opinion until I saw the fruit in the type number and still better developed in Mr. Bessey's

specimens. This resembles more that of *E. asperinum* (*Chiranthus asperinum* Greene) than that of *E. asperum*. The present species is also less densely and more finely strigose than either of them. *E. alpestre* grows at an altitude of 2500 m. or more.

COLORADO: Headwaters of Pass Creek, 1900, *Rydberg & Vreeland*, 6200 (type); mountain near Veta Pass, 6199; Veta Mountain, 6197; tributary of Turkey Creek, 6198; East Indian Creek, 6196; Ojo, 6202; Bald Mountain, near Pikes Peak, 1896, *E. A. Bessey*.

***Draba aureiformis* sp. nov.**

A slender grayish stellate plant with perennial tap-root: stem strict, 2-4 dm. high, simple or branched above, with slender erect branches: basal leaves spatulate, 2-3 cm. long, acute, entire: stem-leaves closely sessile, oblong-lanceolate, acute, entire or sinuately denticulate: petals sulphur yellow, 3-4 mm. long, broadly spatulate: pedicels ascending: pod erect, linear-oblong-lanceolate, 10-15 mm. long, about 3 mm. wide, slightly if at all twisted, stellate: style about 1 mm. long.

This species is nearest related to *D. aurea*, but characterized by the small light yellow petals, the slender style, the less dense pubescence, and slender stem. It grows in dry soil at an altitude of 2700-3300 m.

COLORADO: Headwaters of Pass Creek, 1900, *Rydberg & Vreeland*, 6157 (type); Middle Park, 1861, *C. C. Parry*, 103; Graymount, 1885, *G. W. Letterman*, 28.

***Physaria vitulifera* sp. nov.**

A densely tufted finely stellate-pubescent perennial with deep tap-root. Basal leaves numerous, fiddle-shaped, the larger 4-5 cm. long; terminal lobe nearly orbicular to broadly obovate, subentire, obtuse; upper sinuses rounded: lateral lobes 1-2 pairs, much smaller: stems ascending, or decumbent, 1-2 dm. high: stem-leaves 1-2 cm. long, obovate or oblanceolate, entire: pedicels short, usually curved in fruit: sepals about 4 mm. long, oblong, acute: petals clawed, 8-9 mm. long: fruit obtuse at the base, deeply divided above; cells much inflated, round-obovate, divergent, about 5 mm. in diameter: style about 5 mm. long.

This species, as well as the two following, differs from *P. didymocarpa* in the smaller fruit, which is divided only above, not at

the base. In this respect they resemble *P. Newberryi*; but the fruit is much smaller and not flattened on the sides. *P. vitulifera* differs from the following in the form of the leaves and the curved pedicels. It grows in dry places at an altitude of about 2500 m.

COLORADO: Idaho Springs, 1895, *P. A. Rydberg* (type); Middle Park, 1861, *C. C. Parry*, 101.

***Physaria floribunda* sp. nov.**

Densely tufted perennial with thick tap-root. Flowering stems very numerous, ascending or almost erect, 1–2.5 dm. high: basal leaves less crowded and more erect than in the preceding, oblanceolate or spatulate, sinuately toothed, acute, 5–10 cm. long: stem-leaves oblanceolate, entire, about 3 cm. long: sepals about 5 mm. long, linear-lanceolate: petals bright yellow, 8–9 mm. long, oblanceolate with broad claws: fruit obtuse or slightly cordate at the base, deeply divided above: cells much inflated, about 8 mm. in diameter, almost globular: style 6 mm. long.

In the size and form of the fruit, this species is intermediate between the preceding and *P. didymocarpa*; but it is taller than either. Sometimes the leaves are deeper sinuate, and then become slightly fiddleform; but the terminal lobe is sinuately toothed and acutish. From *P. didymocarpa* it differs in the smaller fruit, which is less cordate at the base, and the longer, more acute leaves. It grows in loose sandy soil in mountain valleys at an altitude of 2000–2700 m.

COLORADO: Sangre de Christo Creek, 1900, *Rydberg & Vreeland*, 6135 (type) and 6136; Hills about Golden, 1892, *Crandall*, 53.

***Physaria acutifolia* sp. nov.**

A small tufted perennial with a deep rather slender tap-root. Basal leaves numerous, 1.5–2.5 cm. long, oblanceolate or obovate, acute, entire or slightly wavy, very finely stellate: stem-leaves rather few, oblanceolate: flowering stems 4–6 cm. long, ascending or depressed: fruit small, obtuse or slightly cordate at the base, deeply divided above: cells inflated, almost spherical, 4–6 mm. in diameter: style about 5 mm. long.

This species differs from *P. didymocarpa* in the smaller size, in the acute leaves, and the smaller fruit, which is more deeply divided above and less so below. In general habit it resembles more *P. Geyeri*, from which it differs in the turgid more spherical cells. It grows in the mountains, reaching an altitude of 3000 m.

COLORADO: Grand Junction, 1893, *Alice Eastwood* (type).

WYOMING: Mount Leidy, 1897, *F. Tweedy*, 391.

***Cardamine cardiophylla* sp. nov.**

Stem stout, 3–10 dm. high, densely hirsute with short white hairs, almost pilose: leaves rounded-cordate or the lower reniform, simple, coarsely sinuately toothed: blades 3–4 cm. broad, more or less pubescent: petioles more or less densely pilose, those of the basal leaves 5–8 cm. long, those of the upper stem-leaves very short: sepals also pubescent, about 3 mm. long: petals white, broadly spatulate, about 8 mm. long: pedicels in fruit spreading, 1.5–2 cm. long: pods 2.5–3.5 cm. long, ascending, 1.5 mm. wide.

This species is nearest related to *C. cordifolia*, and differs mainly in the thicker leaves and the dense pubescence. It reaches an altitude of 3300 m.

COLORADO: Tennessee Pass, Lake County, 1900, *Gco. E. Osterhout*, 2178 (type); 1893, *Dr. Alton Saunders*; Camp beyond Bent's Fort, 1845, *Fremont*, 429.

***Thlaspi Coloradense* sp. nov.**

Perennial; rootstock or caudex cespitose, the branches rosuliferous at the apex. Basal leaves broadly spatulate, 1–2 cm. long, fleshy, 4–7 mm. wide, sinuately crenate or subentire: flowering stems 2–8 cm. long, leafy: stem-leaves oblong or obovate, 3–10 mm. long, obtuse: inflorescence short and dense, even in fruit seldom over 2 cm. long: sepals rounded-ovate, obtuse, with a white margin, about 2 mm. long: petals large, obovate-spatulate, 5–6 mm. long: silicle obovate, about 6 mm. long, only slightly emarginate at the apex: wing-margins very narrow; carina on the sides rather prominent: seeds red, about 1 mm. long.

This species has been included by American authors in *T. alpestre*, which is not found in America. The European species has very small flowers and a different pod which is obcordate with a narrow and deep sinus at the apex. Professor Greene has determined *T. Coloradense* as *T. Fendleri* Gray. The latter was described from flowering specimens and might be the present species; at least it is much like it. Specimens in fruit from the same region as the type of *T. Fendleri* were collected later and were referred by Dr. Gray to *T. Fendleri*; in these the fruit is larger, decidedly inverted triangular in outline, broader margined at the corners and almost truncate at the apex.

T. Coloradense grows at an altitude of 2500 m. or more, among rocks.

COLORADO: Bald Mountain near Pikes Peak, 1896, *E. A. Bessey* (type); South Cheyenne Cañon, Colorado Springs, 1900, *Rydberg & Vreeland*, 6126; West Spanish Peak 6127 and 6128; Pikes Peak, 1894, *E. A. Bessey*; Pikes Peak and Baldy, 1896, *F. Clements*; Pikes Peak and Tennessee Pass, 1893, *De Alton Saunders*; Laramie County, 1893, *C. S. Crandall*, 60; Pikes Peak, 1891, *Dr. E. Penard*, 54; Arapahoe, 55; Los Pinos, 1899, *C. F. Baker*; Cheyenne Mountain and Seven Lakes, 1896, *E. A. Bessey*.

***Thlaspi purpurascens* sp. nov.**

Perennial with a tap-root crowned by a very short caudex and a rosette of leaves; flowering stems generally several, less than 1 dm. high: basal leaves oval or broadly spatulate, 2–3 cm. long, petioled, usually more or less sinuate-dentate: stem-leaves ovate, obtuse, with a truncate base, closely sessile: sepals 2.5–3 mm. long, oblong-oval, obtuse, purplish with broad white margins: petals broadly spatulate, about 6 mm. long: silicle triangular-obovate, distinctly winged above and with a very broad and shallow sinus at the apex, 7–8 mm. long.

This species is closely related to the preceding and intermediate forms are not lacking. The principal difference is in the fruit, which in *T. purpurascens* is comparatively broader, distinctly winged and with a broad and open sinus at the top, almost truncate and less keeled on the sides. The sepals in all specimens seen are purplish and broader, the stem leaves are larger, more ovate and usually with a truncate base, and the branches of the caudex are very short.

ARIZONA: 1876, *E. Palmer*, 571 (type); San Francisco Mountains, 1881, *H. H. Rusby*, 28; 1887, *Dr. E. A. Mearns*, 34; Flagstaff, 1898, *D. T. MacDougal*, 228.

COLORADO: Headwaters of Sangre de Christo Creek, 1900, *Rydberg & Vreeland*, 6125; Iron Mountain, 6124.

***Sophia glandulifera* sp. nov.**

Biennial. Stem simple below, branched above, about 6 dm. high, slightly grayish pubescent with branched hairs, decidedly glandular-viscid above; branches spreading, with upwardly curved ends: leaves pubescent and viscid, bipinnately divided; segments

linear-lanceolate or of the upper leaves filiform, acute or attenuate: flowers light yellow: petals scarcely exceeding the sepals: pedicels very short in flower; in fruit 4-6 mm. long, ascending or almost erect: pods 8-10 mm. long, erect, more or less curved, especially those of the branches, scarcely exceeding 7 mm. in width, more or less constricted between the seeds: beak slender, short, about .5 mm. long: seeds uniserial, red, a little over 1 mm. long.

This species has the short pedicels and erect pods of *S. Hartwegiana*, but the pod of the latter is more slender, and often curved, the whole plant is greener and conspicuously glandular, and the segments of the leaves are more slender. The latter character and the short ascending or erect pedicels distinguish it from *S. incisa* Engelm. It grows at an altitude of 1000-1500 m.

WYOMING: Rolling plains between Sheridan and Buffalo, 1900, *F. Tweedy*, 3592.

***Sedum frigidum* sp. nov.**

Perennial with a fleshy rootstock, dioecious. Stems usually less than 1 dm. high, light green: leaves flat, 1-1.5 cm. long and 5-7 mm. wide, sessile, obovate or oblong-obovate, often dentate above the middle, or entire, acute: inflorescence dense, usually dark purple: flowers 4-5-merous, usually 5-merous: sepals of the staminate flowers lanceolate, acute, 1.5-2 mm. long, dark purple or rarely greenish: petals oblanceolate or oblong, acute, about 3 mm. long, dark purple or very rarely greenish tinged with purple: filaments filiform, purple, about one third longer than the petals, the pistillate similar but with somewhat shorter and more obtuse petals: follicles 3-5 mm. long, oblong, with a very short beak about .5 mm. long, divergent or at last recurved.

This species has gone under the name of *S. roseum* (L.) Scop., but is quite unlike the northern European plant, which must be regarded as the type of *Rhodiola rosea* L. This has a very short, almost tuberous rootstock, more oblanceolate leaves about 3 cm. long, usually with very sharp dentations, usually yellow petals, longer filaments almost twice as long as the petals and follicles, 6-8 mm. long. This form is also found in the mountains of southern Europe; but there seems to be another European plant; this is described and figured under the name *Rhodiola rosea* in the "Flora von Deutschland" published by Schlechtendal, Langethal and Schenk. It resembles more the Rocky Mountain plant in the purple, flowers and short stamens, but it has more inversely deltoid leaves,

the fertile flowers have very minute petals or none and the follicles have long beaks. In all systematic botanies of Scandinavia and Russia, *S. roseum* is described as having yellow petals, which is never the case in the Rocky Mountain and Alaskan plants. In this respect plants from eastern North America agree with the European.

S. frigidum is an alpine-arctic plant growing in Colorado at an altitude of 3000 m. or more. In Montana it is found at an altitude of about 2700 m. and in Alaska at low altitudes. It grows among rocks, associating with several species of *Saxifraga* and *Adoxa Moschatellina*.

MONTANA: Old Hollow Top, 1897, *Rydberg & Bessey*, 4248 (type); Long Baldy, 1896, *Flodman*, 513; Haystack Peak, 1899, *P. Koch*.

COLORADO: West Spanish Peak, 1900, *Rydberg & Vreeland*, 6112 (♀); 6114 (♂) and 6115 (with greenish, merely purple-tinged flowers); Grayback Mining Camp, 6116; Pikes Peak, 1900, *F. Clements*; 1821, *Dr. James*; Arapahoe Peak, 1891, *Dr. E. Penard*; Pikes Peak, 1894, *E. A. Bessey*; 1893, *De Alton Saunders*.

NEVADA: Mineral King, Sierra, Nevada, 1891, *Coville & Funston*, 1529.

IDAHO: Packsaddle Peak, 1892, *Sandberg, MacDougal & Heller*, 860.

WASHINGTON: Mt. Paddo, 1886, *W. H. Suksdorf*, 859.

ALASKA: Muniak Island, 1891, *Jas. M. Macoun*, 48; Shumagin, 1871-1872, *M. W. Harrington*; King Island, 1897, *E. A. McIlhenny*, 83.

***Sedum polygamum* sp. nov.**

Perennial with a thick fleshy rootstock. Stem 1-3 dm. high: leaves obovate or oblanceolate, acute, sessile, flat, entire or minutely denticulate, 1.5-2.5 cm. long: inflorescence dark purple, dense: flowers dioecio-polygamous: sepals of the staminate ones lanceolate, 2 mm. long, acute: petals oblanceolate, dark purple, about 3 mm. long: filaments about half longer than the petals, purple, broader than in the preceding species, abruptly acuminate above: fertile flowers with more lanceolate petals and usually with stamens which however have shorter filaments scarcely exceeding the petals: follicles 6-8 mm. long with an ascending or spreading beak, about 1 mm. long.

This species is closely related to the preceding, but is stouter, the fertile flowers usually with stamens, the follicles larger and with less divaricate beaks. It has also been included in *S. roseum*, but is really nearer related to *S. atropurpureum* of eastern Asia, which however has larger leaves. *S. polygamum* grows at an altitude of 3000 m. or more.

COLORADO: West Spanish Peak, 1900, *Rydberg & Vreeland*, 6113 (type); Silverton, 1895, *F. Tweedy* 124; Mt. Hesperus, 1898, *Baker, Earle & Tracy*, 481; Basin Creek, La Plata Mountains, 480; Mt. Lincoln, 1873, *J. M. Coulter*; Chambers Lake, 1894, *C. S. Crandall*.

NEW MEXICO: White Mountains, 1897, *E. O. Wootton*, 677.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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STUDIES ON THE ROCKY MOUNTAIN
FLORA.—VI

BY P. A. RYDBERG

NEW YORK
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Studies on the Rocky Mountain Flora.—VI

BY P. A. RYDBERG

Salix padophylla n. n.

S. padifolia Rydb. Bull. Torr. Club, 28: 272. 1901. Not Anderson.

In the May number of the Bulletin appeared a new species of willow under the name *S. padifolia*. The name should have been *S. padophylla*, as *S. padifolia* is preoccupied by one of Anderson's species. Besides, *padus* is originally a Greek word, *παδος*.

Trifolium stenolobum sp. nov.

A densely caespitose and scapose perennial. Branches of the caudex covered by the large stipules which are 2 cm. long; petioles 5–10 cm. long, finely strigose; leaflets 3, narrowly lanceolate or oblanceolate, 1.5–4 cm. long, finely strigose, very acute or acuminate; scape 1–1.5 dm. long; heads many-flowered; bracts minute; flowers reflexed in fruit; calyx-tube silky-strigose, 4–5 mm. long; teeth almost filiform, 7–9 mm. long; banner about 18 mm. long, obtuse, mucronate.

This is related to *T. dasyphyllum* but is easily distinguished by the minute bracts, the long slender calyx-teeth and the larger corolla. It grows at an altitude of 3600 m.

COLORADO: La Plata Mountain, 1896, *F. Tweedy*, 457 (type in U. S. Nat. Herb.).

TRIFOLIUM SUBCAULESCENS A. Gray, Ives, Rep. Colo. Riv. Bot.
10. 1860

Trifolium nemorale Greene, Pittonia, 4: 136. 1900.

Dr. Watson referred this species to *T. gymnocarpum*, to which it is nearest related, but it differs in the larger size and the many-flowered head. The specimen of C. F. Baker's no. 446 in the herbarium of the New York Botanical Garden matches perfectly Newberry's specimen in the Columbia University herbarium. The former is the type number of *T. nemorale* Greene, and the latter that of *T. subcaulescens* A. Gray. Unless the type sheets repre-

sent different species from those represented in our herbaria, Prof. Greene's name has to pass into synonymy.

Trifolium bracteolatum

Trifolium lilacinum Rydb. Bull. Torr. Club, 28: 37. 1901.
Not Greene. 1896.

Vicia producta sp. nov.

A very slender, sparingly hairy caespitose perennial. Stems decumbent or ascending, 2-3 dm. long, much branched and leafy, striate and somewhat angled: stipules narrow, semi-hastate, entire, 3-5 mm. long; leaflets 3-5 pairs, oblong to linear, 5-15 mm. long, obtuse, mucronate; tendrils 3-cleft: peduncles 2-4 cm. long, usually 2-flowered, produced beyond the upper flower: calyx-tube about 2 mm. long, strigose, teeth about 1 mm. long, lanceolate-subulate: corolla about 8 mm. long, yellowish-white, tipped and tinged with purple.

This species is probably closest related to *V. humilis* H. B. K., but is characterized by having the peduncle produced beyond the two flowers and by different calyx-lobes. The type was growing among rocks on the south side of a butte, at an altitude of about 2400 m.

COLORADO: Butte, 5 miles southwest of La Veta, 1900, *Rydb. & Vreeland*, 6006.

Primula Americana sp. nov.

Primula farinosa A. Gray, Syn. Fl. 2¹: 58, in part. 1878.
Not L. 1753.

Perennial with a short rootstock and fleshy-fibrous roots. Basal leaves oblong or oblong-ob lanceolate or spatulate, 2-8 cm. long, obtuse, gradually contracted at the base, usually with short winged petioles, sinuate dentate above the middle or subentire, thin, more or less mealy, especially on the lower surface: scape 1-2 dm. high, mealy when young: bracts 6-10 mm. long, linear-lanceolate, usually acute: pedicels in flower little if any exceeding the bracts, in fruit sometimes 2 cm. long, erect from the beginning: calyx more or less mealy, 6-8 mm. long, lobes oblong-obtuse: corolla lilac; tube 8-9 mm. long, only slightly exceeding the calyx; lobes of the corolla obcordate, 2-3 mm. long.

This species has been confused with *P. farinosa*, but I think it distinct. All specimens from the Rocky Mountain region under that name differ from the European and especially the Scandi-

navian *P. farinosa* in the longer bracts, in the longer calyx and in the short corolla lobes. The specimens of northeastern America seem to be like the European plant. In the latter the bracts are only 4-6 mm. long, acuminate, the calyx less than three fourths the length of the tube of the corolla and the lobes of the latter 4-5 mm. long. *P. Americana* grows in swamps and wet meadows of the Rocky Mountain region at an altitude of 1200-2500 m.

MONTANA: Deer Lodge, 1895, *P. A. Rydberg*, 2746 (type).

WYOMING: Little Laramie River, 1896, *Aven Nelson*, 1961; Hams Fork and La Barge, 1900, *C. C. Curtis*.

ALBERTA: Devil's Head Lake, Banff, 1899, *W. C. McCalla*, 2422.

COLORADO: North Park, 1896, *Geo. E. Osterhout*.

Cuscuta gracilis sp. nov.

Stem filiform, about .25 mm. in diameter. Flowers in dense globular clusters: calyx gamosepalous but cleft to near the base, lobes ovate: corolla urceolate, less than 2 mm. high, lobes ovate, widely spreading, acute, delicate, about 1 mm. long; scales ovate, crenate, not divided, almost half as long as the corolla-tube: filaments subulate, about twice as long as the anthers: styles distinct, equal, about as long as and somewhat thicker than the red filiform curved stigmas: capsule about 2 mm. high, acute-globose, circumscissile near the base: seeds about 1 mm. long.

This species is nearest related to *C. epilium*, which, however, has shorter and broader corolla-lobes, shorter filaments, scarcely longer than the anthers and short emarginate and crenate scales. *C. gracilis* grows parasitic on species of *Erigeron*, *Chrysothamnus* and *Solanum*.

WYOMING: Rolling plains between Sheridan and Buffalo, 1900, *F. Tweedy*, 3292 (type); Laramie, 1894, *Aven Nelson*, 1139.

Cuscuta megalocarpa sp. nov.

Stem stout, usually over 1 mm. in diameter. Flowers in dense globular clusters: pedicels very short, at most 2 mm. long: calyx gamosepalous, lobes rounded, scarcely 1 mm. long: corolla about 3 mm. high and broad, lobes broadly triangular, acutish, about 1 mm. long, with incurved tip; fringed scales attached near the bottom, equalling about half the corolla-tube, deeply 2-lobed, and fringed only in the open sinuses: stamens about as long as the lobes of the corolla, filaments subulate, about twice as long as the

rounded anther: styles distinct, short, stigmas capitate: capsule 5-6 mm. in diameter, acute-globose, about 4-seeded: seeds about 2.5 mm. long and 2 mm. broad, finely muricate.

A plant parasitic on willows and other shrubs, at an altitude of about 2000 m.

COLORADO: Cucharas Creek, near La Veta, 1900, *F. K. Vreeland*, 670.

WYOMING: Dayton, Sheridan Co., 1899, *F. Tweedy*, 2278.

***Monarda comata* sp. nov.**

Perennial with a horizontal, slender rootstock. Stem obtusely 4-angled, 4-6 dm. high, simple, sparingly silky-villous, especially below the nodes and on the upper portion: lower leaves with more or less hairy petioles, which are about 1 cm. long, the upper sessile; blades ovate or lance-ovate, more or less cordate at the base, acute or acuminate, serrate with small teeth which are directed forward, 4-6 cm. long, sparingly silky-strigose on both sides: bracts green or tinged with purplish, ovate, 1-2 cm. long: calyx about 1 cm. long, minutely puberulent, with a ring of hairs at the base of the teeth, which are subulate, .7 mm. long: corolla red-purple, almost wine-color, densely villose-puberulent, the exserted portion about 2 cm. long.

This is nearest related to *M. stricta* Wooton, but differs in the long pubescence of the stem, leaves and bracts, shorter calyx-teeth and darker flowers. It grows in meadows among bushes, at an altitude of 2000-2500 m.

COLORADO: Wahatoya Creek, 1900, *Rydberg & Vreeland*, 5673 (type); Ruxton, 1900, *Fred Clements*.

***Castilleja Wyomingensis* sp. nov.**

A more or less caespitose perennial with a short woody caudex. Stems 3-4 dm. high, striate, sparingly puberulent and the upper portion viscid-pubescent: leaves linear, 4-5 cm. long, 4-7 mm. wide, minutely puberulent, more or less distinctly 3-nerved, entire, or the upper 3-lobed: bracts lanceolate to ovate, puberulent and ciliate on the margin and veins tinged with sulphur-yellow, 3-lobed at the apex or the lower entire, middle lobe oblong and rounded at the apex, the lateral ones lanceolate or linear, acute: calyx villose, nearly 2 cm. long and almost equalling the corolla, sulphur-yellow, cleft about half way down, slightly deeper on the lower than on the upper side, lateral cleft 3-4 mm. deep: corolla greenish, tinged and bordered with sulphur-yellow, galea about 6 mm. long, lip about 2 mm.: capsule ovoid, 12-13 mm. long.

The species is nearest related to *C. sulphurea*, from which it differs in the narrow leaves and in being more puberulent. It grows in northern Wyoming at an altitude of 2200–2700 m.

WYOMING: Big Horn Mountains, Sheridan Co., 1899, *F. Tweedy*, 2341 (type) and 2342; Headwaters of Clear Creek and Crazy Woman River, 1900, *Tweedy*, 3400.

***Pentstemon suffrutescens* sp. nov.**

Pentstemon caespitosus var. *suffruticosus* A. Gray, Syn. Fl. 2¹: 270. 1878. Not *P. suffruticosus* Dougl. 1846.

Excellent specimens of what I take to be Gray's variety cited above, which was described from imperfect material, have been collected by Mr. Tweedy, and these show that the plant is nearer related to *P. pumilus* than to *P. caespitosus*, but the calyx lobes are broader, shorter and blunter than in that species, the corolla slightly smaller and the leaves glabrous.

COLORADO: Ridgway, 1895, *F. Tweedy*, 170.

***Sambucus microbotrys* sp. nov.**

A low shrub, 5–20 dm. high, glabrous throughout and with pale green foliage. Leaflets ovate or rarely ovate-lanceolate, acute or short-acuminate, 3–9 cm. long, mostly rounded and oblique at the base, coarsely serrate: cyme thyrsoid-paniculate, small, about as long as broad, about 3 cm. in diameter and of the same height; flowers whitish: fruit bright red, 4–5 mm. in diameter: seeds finely punctate-rugose.

This species is nearest related to *S. pubens* and perhaps all specimens from the southern Rockies referred to that species belong here. The main distinctions from *S. pubens* are the total absence of pubescence and the smaller inflorescence. It grows at an altitude of 1500–2700 m.

COLORADO: Bottomless Pit, and below Halfway House, Pike's Peak, 1896, *E. A. Bessey* (type); Gray's Peak, 1895, *P. A. Rydberg*; East Indian Creek, 1900, *Rydberg & Bessey*, 5582; Little Veta Mountain, 5583.

***Chrysothamnus filifolius* sp. nov.**

A small shrub, about 3 dm. high, very bushy. Bark of the stems and larger branches gray and somewhat fissured, that of the young branches white and shining: leaves very narrow, linear-

filiform, 1–2 cm. long, less than 1 mm. wide, dark green and glabrous except the minutely scabrous-ciliolate margins: cyme large, flat-topped: heads very numerous, 5–6 mm. high, 2 mm. in diameter, turbinate; bracts in 5 vertical rows with usually 3 in each row, lanceolate-acuminate, the outer with green tips, the inner wholly chartaceous.

In habit and leaves, this species resembles *C. stenophyllus*, but the leaves are still narrower and in that species the bracts are obtuse or merely acute.

COLORADO: Granite, 1896, *Fred. Clements*, 390.

***Chrysothamnus scoparius* sp. nov.**

Perennial with a woody caudex and deep tap-root. Stems 1–2 dm. high, glabrous and shining, with a white bark: leaves narrowly linear, light bluish-green, glabrous, 2–3 cm. long, a little over 1 mm. wide, more or less twisted: cyme flat-topped: heads numerous, 6–8 mm. high, 2–3 mm. wide; bracts chartaceous, lanceolate, acuminate.

This species is still more like *C. stenophyllus* in habit, but the bracts are different, being acuminate instead of obtuse or acute and more keeled. The perennial portion is also much shorter and the general color of the plant is much lighter.

COLORADO: Mesas, La Veta, 1900, *F. K. Vreeland*, 698.

***Aster crassulus* sp. nov.**

Aster multiflorus A. Gray, Pl. Wr. 2: 75. In part. 1853.

Aster incano-pilosus Rydb. Mem. N. Y. Bot. Gard. 1: 393. In part. 1900.

Perennial with a horizontal, stoloniferous rootstock. Stems erect or ascending or rarely decumbent, usually simple below, branched above, 4–7 dm. high, terete, brownish, densely hirsute with short divaricate hairs: stem-leaves linear, or oblong-linear, 3–6 cm. long, 2–3 mm. wide, rather firm, hirsute with short spreading hairs, sessile and slightly clasping, in age usually reflexed, acute with a short spinulose tip; those of the branches smaller; those of the branchlets only 3–5 mm. long and merging into the bracts of the involucre: heads numerous, borne at the end of leafy branchlets which are 1–2 cm. long; involucre turbinate, 5–8 mm. high, 8–10 mm. broad; bracts in 3–4 series, the outer successively shorter, broadly spatulate, minutely spinulose-mucronate, very thick, hirsute especially on the margin, chartaceous at the base with a broadly oval herbaceous tip: rays numerous, white, 5–7 mm. long and fully 1 mm. wide: achenes strigose.

This is a member of the *A. multiflorus* group and has been confused with *A. commutatus* (T. & G.) Gray or *A. incano-pilosus* Sheldon. In *A. commutatus*, the stem is strigose-pubescent, the branchlets more elongated and the outer bracts longer than in *A. crassulus* and often equalling or surpassing the inner bracts. It may be the same as described by Lindley in Hooker's Flora and DeCandolle's Prodrômus as "*A. ramulosus* β , incano-pilosus"; but here it is to be noticed that the word "incano-pilosus" is printed in the same type as all the descriptions and not the special type used for names. Hence "incano-pilosus" was a descriptive term for the *A. ramulosus* β , and not the name. If, however, it should be taken as a name, which Mr. Sheldon did, it is a *nomen nudum*, as no further description is given, and then should be disregarded. As Sheldon's *Aster incano-pilosus*, which is amply distinct, has as a synonym, the older *A. commutatus* (T. & G.) Gray it must be dropped and *A. commutatus* substituted.

A. crassulus grows on dry plains and table-land at an altitude of 1200 m.

COLORADO: Mesas, La Veta, 1900, *F. K. Vreeland*, 690a (type) and 690; Denver, 1871, *Dr. Geo. Smith*, 83; Ridgway, 1894, *F. Tweedy*, 306; Pagosa Spring, 1899, *C. F. Baker*, 637.

NEW MEXICO: 1851, *C. Wright*, 1155; Rio Dolores, *Newberry*.

CALIFORNIA: Valley, near San Filipe, 1858, *S. Hayes*.

WYOMING: Bear Lodge Mountains, 1898, *L. W. Carter*; Moorcroft, 1897, *L. W. Carter*; Dayton, 1899, *F. Tweedy*, 2031.

NORTH DAKOTA: Minot, 1891, *Wright*; Custer, 1892, *Rydberg*, 773.

MONTANA: Park Co., 1887, *F. Tweedy*, 359; Colgate, *Sandberg*, *MacDougal & Heller*, 1021; Montana Valley, Madison Co., 1899, *Aven & Elias Nelson*, 6839.

Aster exiguus (Fernald)

Aster ciliatus Muhl.; Willd. Sp. Pl. 3: 2027. 1804. Not Walt. 1788.

Aster hebecladus A. Gray, Syn. Fl. 2¹: 185, under *A. multiflorus*. Not DC.

Aster multiflorus var. *exiguus* Fernald, Rhodora, 1: 187. 1899.

I think that *Aster ciliatus* Muhl. is distinct from *A. multiflorus*;

but unfortunately it is antedated by *A. ciliatus* Walt. In *A. multiflorus* the pubescence is mostly appressed and the bracts are narrow-oblongate and rather thin. In *A. exiguus* the pubescence is much denser and divaricate and the bracts are thick, broadly spatulate or obovate. In fact *A. exiguus* differs from the preceding only in the smaller, more crowded heads and the shorter rays; the former are less than 5 mm. high and the rays are only 5–6 mm. long. The New Mexican form which Gray regarded as *A. hebecladus* DC. and for which Dr. Greene has revived the name belongs here, but is evidently not *A. hebecladus* DC. for this is described as having glabrous stem and linear bracts.

A. exiguus grows on prairies and plains along roads, etc., and westward is much more common than *A. multiflorus*. It ranges from Vermont and Pennsylvania to Washington and south to Texas and Arizona.

***Machaeranthera rubricaulis* sp. nov.**

Biennial or perhaps perennial. Stem erect or nearly so, simple below, branched above, 4–6 dm. high, terete, striate, usually tinged with red or purple, finely strigose-puberulent, not viscid: leaves linear or linear-oblongate, sessile, acute, entire or sparingly dentate, scabrous-ciliolate on the margins; the largest 8 cm. long, and 8 mm. wide: heads corymbose-cymose, numerous: involucre 10–12 mm. high, 12–15 mm. in diameter: bracts numerous, linear-lanceolate with attenuate, almost terete squarrose tips, viscid-puberulent: rays numerous, dark blue, about 12 mm. long and 1 mm. wide: pappus sordid: achenes flat, sparingly and minutely strigose.

The species grows in dry soil at an altitude of 2000–2700 m.

COLORADO: Mesas, La Veta, 1900, *F. K. Ireland*, 681 (type); Telluride, 1894, *F. Tweedy*, 304 and 305.

***Erigeron laetevirens* sp. nov.**

Perennial with a woody tap-root. Stems several, 1.5–2 dm. high, slender, erect or ascending, striate, silky strigose: basal leaves very narrowly linear-oblongate, acute, 5–10 cm. long, 1–3 mm. wide, sparingly strigose; stem-leaves narrowly linear, 2–6 cm. long, scarcely over 1 mm. wide: heads solitary: involucre 12–15 mm. in diameter, grayish villous-hirsute: bracts in 2–3 series, subequal, linear-lanceolate, long-acuminate: rays numerous, blue or purple, 7–8 mm. long, 1–1.5 mm. wide.

This species is nearest related to *E. Montanensis*, from which it differs in the narrower, blue or purple rays and longer and less pubescent leaves. It grows at an altitude of 2000–2700 m.

WYOMING: Little Goose Creek, 1899, *E. Tweedy*, 2005 (type); Headwaters of Clear Creek and Crazy Woman River, 1900, 3010.

***Carduus Centaureae* sp. nov.**

(?) *Cnicus carlinoides* var. *Americanus* A. Gray, Proc. Am. Acad. 10: 48. 1874. Not *Cirsium acaule* var. *Americanus* A. Gray. 1863.

(?) *Cnicus Americanus* A. Gray, Proc. Am. Acad. 19: 56.

Biennial or perennial. Stem rather slender, 6–10 cm. high, striate, often tinged with red, slightly floccose when young: basal leaves about 2 dm. long, thin-petioled, deeply pinnatifid to near the midrib, above light green, sparingly floccose when young, glabrate in age, beneath more or less permanently grayish-tomentose; lobes lanceolate or triangular, 2–4 cm. long, more or less toothed and tipped with weak spines, 1–3 mm. long; lower stem-leaves similar but petiole more winged, dilated at the base and short decurrent; the upper sessile and clasping with an auricled base; the uppermost lanceolate and undivided: heads 2–2.5 cm. high and 1.5–2 cm. in diameter: outer bracts narrowly lanceolate, yellowish, often with darker center, fimbriate on the margin and tipped with a flat weak spine 1–2 mm. long; the inner with dilated deltoid scarious fimbriate tips which are merely acuminate: flowers ochroleucous.

This species may be the *Cnicus Americanus* A. Gray or *Carduus Americanus* Greene, but the name *Americanus* is preoccupied. The species is, however, not nearest related to *C. Parryi*, where Dr. Gray placed it; but to *C. leiocephalus* and *C. canovirens*, from which it differs in the less spinose, more dilated and fimbriate bracts. A seedling of apparently this species was collected by Cowen and it has long oblanceolate 3–4 dm. long, undivided leaves. It grows at an altitude of 2200–2600 m.

COLORADO: Laramie County, 1895, *J. H. Cowen* (type); 4-mile Hill, Routt County, 1896, *C. F. Baker*; Penn's Gulch, 1865, *Letterman*, 78.

***Carduus erosus* sp. nov.**

Biennial. Stem stout, about 7 dm. high, angled and striate, often red, loosely floccose when young: lower leaves about 2 dm. long, rather thin, green and slightly floccose above when young:

grayish-tomentose beneath, deeply pinnatifid to about one fourth from the midrib: lobes about 2 cm. long, lanceolate, few toothed or lobed and tipped with moderately strong spines 4-10 mm. long: heads hemispherical, 2.5-3 cm. high and 2.5-3.5 cm. broad: outer bracts ovate, slightly floccose when young, entire, with a narrow dorsal line, tipped with weak spines 1-2 mm. long, the inner with dilated deltoid-erose scarious acuminate tips: flowers ochroleucous.

A species closely related to the preceding, differing in the larger heads, longer spines, broader bracts and with erose instead of fimbriate tips. It grows in moist meadows at an altitude of about 2200 m.

COLORADO: Durango, 1896, *Frank Tweedy*, 517 (type in U. S. Nat. Herb.).

***Carduus Americanus* (A. Gray).**

Cirsium acule var. *Americanus* A. Gray, Proc. Acad. Phila. 1863: 68.

Cnicus Drummondii acaulescens A. Gray, Proc. Am. Acad. 10: 40, in part.

Dr. Gray's *Cirsium acaule* var. *Americanum* is amply distinct from *C. Drummondii* not only by the acaulescent habit, but also by the narrower bracts and their long stout spines which are 1-2 cm. long while in *C. Drummondii* they are only a few mm. in length and very weak. It is an alpine species growing at an altitude of 2800-3500 m. To this belong the following specimens.

COLORADO: Silver Plume, 1895, *P. A. Rydberg*; Como, South Park, 1895, *C. S. Crandall*; South Park, 1884, *Letterman*.

***Carduus acaulescens* (A. Gray)**

Cnicus Drummondii var. *acaulescens* A. Gray, Proc. Am. Acad. 10: 40, in part.

Gray's variety *acaulescens* was based on two previously published things, viz., *Cirsium acaule* var. *Americanus* A. Gray, given above, and *Cirsium Drummondii*, "acaulescent form" D. C. Eaton in King's Report. As the first already has a valid name, I here adopt the name *acaulescens* for the other part on which the variety was founded. *C. acaulescens* resembles closely *C. Americanus* in habit, but the spines of the outer and middle bracts are shorter and

weaker, seldom over 5 mm. long, and the inner are acuminate, wholly unarmed. The true *C. Drummondii*, even in its subacaul-
escent state, has very broadly ovate outer bracts and the spine is
so fine that it is better called a bristle. The inner bracts have a
long acuminate very crisp tip. In *C. aculeescens* it is scarcely
crisp. The following specimens belong to *C. aculeescens*:

UTAH: Bear River Valley, 1869, *S. Watson*, 690.

WYOMING: Woods Creek, 1897, *Aven Nelson*, 3483.

COLORADO: Grizzly Creek, 1896, *C. F. Baker*.

***Carduus oreophilus* sp. nov.**

Cirsium Drummondii, D. C. Eaton, King's Rep. 5: 195. 1871.

Not T. and G.

Biennial stem 4-8 dm. high stout, angled and striate, slightly
arachnoid-hairy when young, leafy: basal leaves about 2 dm.
long, thin, short-petioled, green and glabrate above, more or less
grayish-tomentose beneath, pinnately lobed a little more than
half way to the midrib; lobes triangular, usually 2-3-lobed, with
rather slender spines 3-10 mm. long: heads hemispherical, 2-2.5
cm. high, 2.5 cm. broad: outer and middle bracts narrowly lan-
ceolate, slightly arachnoid, tipped with flat spines 3-6 mm. long,
the inner with a long attenuate soft tip: flowers red.

This species has been included in *C. Drummondii* but is taller
with smaller head, narrower bracts, the outer with longer spines,
and the tips of the inner scarcely crisp. It grows at an altitude of
1500-3000 m.

COLORADO: Georgetown, 1895, *P. A. Rydberg* (type); Pagosa
Springs, 1899, *C. F. Baker*, 644.

NEVADA: Run Valley, 1868, *S. Watson*, 689.

***Carduus griseus* sp. nov.**

Biennial. Stem stout, sparingly floccose when young, angled
and striate: basal leaves oblanceolate in outline, thin, glabrate
above, grayish-tomentose beneath, deeply pinnately divided; seg-
ments 3-4 cm. long, deeply 2-3-lobed and toothed, tipped and
margined with rather slender spines 3-5 mm. long; the upper
similar but less deeply divided, sessile and half clasping by the
dilated rounded shortly decurrent base: heads about 3 cm. high
and broad: bracts subequal, without dorsal glandular ridge, the
outer narrowly lanceolate, with a long-attenuate tip gradually
changing into a flat spine, and somewhat lacinate or spinulose-

dentate on the margin; the inner bracts less rigid, their tips not spinose but long-attenuate, scarious and somewhat crisp: flowers ochroleucous.

This species is probably nearest related to *C. leioccephalus* (D. C. Eaton) Heller but differs in the less divided, less spinose leaves and the bracts which are lacking the long yellow spines on the margins. *C. leioccephalus* has red flowers. *Carduus griseus* grows at an altitude of 3400 m.

COLORADO: Telluride, 1894, *F. Tweedy*, 321 (type in U. S. Nat. Herb.).

***Carduus pulcherrimus* sp. nov.**

Biennial. Stem about 4 dm. high, very leafy, grayish-tomentose, especially when young, angled: lower leaves 1-1.5 dm. long, oblanceolate in outline, short-petioled, pinnately divided, bright green and glabrate above, densely white-tomentose beneath; segments lanceolate or triangular, lobed and toothed with slender spines 3-5 mm. long; the upper leaves similar, sessile and half clasping: heads 2.5-3 cm. high, 2.5-4 cm. broad: outer bracts lanceolate with a narrow glandular ridge, slightly floccose, tipped with yellow spines about 5-7 mm long; the innermost narrowly lanceolate and with long-attenuate tips: flowers rose-colored.

In habit this species resembles most *S. undulatus* and *S. ochrocentrus*, but has smaller heads, narrower bracts and narrower glandular ridge. It is perhaps intermediate between those species and *C. canovirens*, from which latter it is easily distinguished by the dense tomentum on the lower surface of the leaves. It grows in open woods, etc., at an altitude of about 2500 m.

WYOMING: Headwaters of Clear Creek and Crazy Woman River, 1900, *F. Tweedy*, 3048 (type); Medicine Bow, 1898, *Elias Nelson*, 4396.

***Carduus oblanceolatus* sp. nov.**

Apparently perennial. Stem rather slender, 3-6 dm. high, almost terete, densely white-tomentose: lower leaves about 1 dm. long, oblanceolate, thick, short-petioled, merely spinulose-dentate or rarely with a few triangular lobes, loosely floccose above, densely white-tomentose beneath, spines slender, 2-5 mm. long; upper leaves lanceolate, sessile and half clasping: heads 1-3, campanulate, 3-3.5 cm. high, 1.5-2.5 cm. broad: bracts slightly floccose at first, with a narrow glandular dorsal ridge, the outer ovate-lanceolate, the middle lanceolate, with a slender divergent spine,

3-5 mm. long, the innermost long-attenuate, unarmed : flowers rose-colored.

This species is nearest related to *C. Flodmanii*, differing in the more simple habit, the smaller, thicker, not pinnatifid leaves and shorter and weaker spines. From *C. altissimus* it differs in the denser tomentum, the simple habit, the narrower and fewer bracts and their narrower dorsal ridges.

COLORADO : Twin Lakes, 1896, *Fred. Clements*, 385 (type).

***Agoseris arachnoidea* sp. nov.**

Perennial with a tap-root, more or less floccose throughout. Leaves 1.5-2 dm. long, more or less runcinate-lobed, oblanceolate in outline, long-attenuate at the apex, densely floccose when young, more glabrate in age : scape 1.5-4 dm. high, densely woolly above, less so below : head 2-2.5 cm. high, 1.5-2 cm. broad : bracts in about 3 series, linear-lanceolate, long-attenuate, the inner one-third longer than the outer : flowers at least in age rose-purple : beak of the achenes fully as long as the body.

Perhaps nearest related to *A. aurantiaca* but differing in the larger heads, the dense pubescence and the lighter flowers. It grows in meadows at an altitude of 2000-2800 m.

COLORADO : Gray-Back Mining Camp, 1900, *Rydberg & Ireland*, 5553 (type) ; La Veta, 1896, *Fred. Clements*, 167.

***Agoseris pubescens* sp. nov.**

Perennial with a tap-root and short branching caudex. Leaves narrowly oblanceolate, about 1 dm. long, .5-1 cm. wide, acuminate, slightly glaucous but even in age villous-pubescent : scape 1.5-2 dm. high, sparingly villous : involucre about 2 cm. high and 1.5 cm. wide, villous and somewhat viscid : bracts with a dark median line and sometimes tinged with purple, the outer ones ovate-lanceolate, about $\frac{2}{3}$ the length of the linear-lanceolate long-acuminate inner ones : flowers lemon-yellow, the outer striate or tinged with purple : beaks of the achenes short and striate throughout.

This species is nearest related to *A. glauca* and *A. scorzoncracifolia* but differs in being very pubescent. It grows in moist meadows at an altitude of 2000-2500 m.

WYOMING : Big Horn Mountains, Sheridan County, 1899, *F. Tweedy*, 2055 (type) ; Buffalo Fork, 1897, 578 ; Amethyst Creek, 1899, *Aven & Elias Nelson*, 5769 (in part).

Taraxacum Alaskanum sp. nov.

A low delicate plant with perennial root: leaves linear-oblan-
ceolate in outline, 3-5 cm. long, deeply runcinate-pinnatifid with
triangular retrorse lobes: scape 4-5 cm. high: involucre cam-
panuate, 10-12 mm. high, 6-8 mm. broad: bracts fuscous, not
corniculate; the inner linear-lanceolate, long-acuminate; the outer
scarcely half as long, lanceolate, spreading or somewhat reflexed:
achenes brownish, spinulose-muricate above, fusiform, 4 mm. long.

This in size and habit most resembles *T. scopulorum*, but is
easily distinguished by its triangular acute lobes. It was found
"on steep side bank facing the ocean."

ALASKA: Pt. Barrow, 1898, *McIlhenny*.

Crepis glaucella sp. nov.

Perennial with a slender tap-root. Stem slender, about 3 dm.
high, glabrous and shining: basal leaves glabrous and shining,
somewhat glaucous, thin, 5-10 cm. long; blades oblanceolate,
acute at the apex, tapering downward into a more or less winged
petiole, remotely sinuate-dentate with divaricate or retrorse short
teeth or entire; stem-leaves 1-2, much reduced, 1-2 cm. long,
linear or nearly so: heads 1-4, on slender branches: involucre
turbinate, about 1 cm. high and 6-8 mm. wide, sparingly hirsute;
bracts linear-lanceolate, acuminate: achenes brown, 10-striate, gla-
brous: pappus white.

This species is nearest related to *C. glauca* but differs in the
smaller, narrower, longer-petioled leaves and hirsute involucre.

WYOMING: Pacific Creek, 1897, *F. Tweedy*, 603.

HIERACIUM MACRANTHUM Nutt. Trans. Am. Phil. Soc. II. 7: 446.

1840

Hieracium umbellatum Hook. Fl. Bor. Am. 1: 300, in part;
Rydb. Mem. N. Y. Bot. Garden 1: 463, mainly. Not L.

The plant of the Rocky Mountain region which has been re-
ferred to *H. umbellatum* and sometimes to *H. Canadense* is quite
distinct from both. The leaves are usually broader than in the
first but narrower than in the second and the heads are usually
fewer than in either. The best character by which to distinguish
it is, however, the pubescence. The leaves are densely puberu-
lent and decidedly scabrous-ciliolate on the margins. The upper
portion of the stem and the branches of the inflorescence are also
scabrous-puberulent.

H. macranthum ranges from Wyoming and Washington northward to subarctic America. It apparently also extends eastward to the upper Mississippi River (Nicollet's specimens seem to belong here) and therefore may be Schweinitz' *H. scaberrimum*, which has been referred to *H. umbellatum* and *H. Canadense*. I have not seen Schweinitz' original description and can not venture an opinion. Nuttall's name belongs to the plant without any doubt.

***Hieracium Columbianum* sp. nov.**

Perennial. Stem about 6 dm. high, terete, more or less tinged with purple, more or less white- or yellowish-hirsute below, glabrous or puberulent above : lower leaves oblanceolate, 8–10 cm. long, light green and somewhat glaucous beneath, usually more or less silky-hirsute, sinuately dentate, acute ; the middle leaves lanceolate or ovate-lanceolate with rounded or obtuse base, sessile, more glabrate ; the uppermost much reduced and bract-like : inflorescence corymbose-cymose, small and contracted : heads 2–6, 12–15 mm. high : bracts lanceolate, unequal and more or less imbricated, dark, puberulent when young, glabrous in age : pappus very light brownish.

This species is nearly related to *H. Canadense* and *H. umbellatum*, but differs from both in the long hairs of the lower part of the plant. The leaves are thin as in *H. Canadense* but narrower and the heads are fewer. It grows in low ground at an altitude of about 600 m.

IDAHO : Priest River Valley, 1900, *D. T. MacDougal*, 109 (type) ; cañons near Farmington Landing, 1892, *Sandberg, MacDougal & Heller*, 573.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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VANISHING WILD FLOWERS

BY ELIZABETH G. BRITTON

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VANISHING WILD FLOWERS

BY ELIZABETH G. BRITTON

A number of articles on this topic have been published this year. They have awakened the interest of many readers, caused much comment and discussion, and prompted investigation as to the reasons for this calamity, which, if it does actually come to pass, is as much to be deplored as the extermination of the buffalo, the seal or the beaver. As in the case of mammals and birds, greed and thoughtlessness combine to do the harm, and fashion and selfishness are the motives.

The New York Tribune of May 5th had the following article:

"Now that spring is really here, the picnicking parties are invading the woods north of the Harlem, and have begun the annual systematic destruction of a large proportion of all wild flowers within reach. The authorities of the Botanical Gardens are on the lookout for them, and within their own precincts will guard the blossoms as thoroughly as possible under a well planned system; but the rest of the Bronx will be at their mercy, and that means death to many a poor little plant. It is not that these ruthless explorers fail to appreciate the beauty of flowers—they "just love them," in all probability. The trouble arises from their ignorance of the extent of the damage they do, and from an utter inability to comprehend that a flower or anything in the vegetable world has rights which the lord of creation himself is bound to respect. Thanks to the picnickers and alleged botanists, the arbutus, loveliest of spring blossoms, has been almost exterminated in the Bronx region. Its delicate pink and white used once upon a time to hide under the leaves all through the northern woods in that part of the suburbs; now it may be found only in spots where it commands less enthusiastic admiration. The mountain laurel has shared a similar fate."

"The most curious feature of this destructive energy is that the plants and flowers so carelessly torn from their homes probably give little or no satisfaction to those who take them away with them. Is there, for instance, a more unsatisfactory flower to make attractive in a vase than the arbutus? It pines for its screen of leaves; the loveliness that seems so perfect when half hidden becomes quite inadequate when pulled out into the glare of the day and put down in a city room. The same is true of most other delicate wood plants. They depend upon the charm of their surroundings." In *The House Beautiful*, July, 1901.

"Is there a flower lover who has gone out into the country with a party of young people unaccustomed to find themselves surrounded with green who has not noted with something very like hopeless rage the immediate rush on every growing thing in the neighborhood, its instant uprooting and subsequent careless tossing aside? Later in the day, before going home, when all the blossoms in the immediate neighborhood have been destroyed, there is a search for fresh fields, and another spot is denuded. A few dejected blossoms are all that is left when home is reached; nothing of any value remains out of all the lives butchered to make an East Side holiday. The saddest part of it is, not that the children do it, for that might be pardoned on the score of ignorance, but that those in authority permit it without a remonstrance."

"The flower's right to existence nobody takes into account, or the harm done to the children by allowing them to think that they may destroy life as they choose."

And in this connection arises the question of public rights on private property. I know that less than fifty miles from New York, a man of wide and varied culture and sympathies, a member of a variety of horticultural and agricultural societies, owning a large tract of land away from any large town, has attempted to plant the waste roadside places and private woodland with wild and cultivated flowers, and repeatedly seen great bunches of them carried off by people, walking or driving by, who did not realize all the trouble and expense he had been to, in order to beautify the roadsides *for them* and *for others* who might come later. Many a prized Azalea bush has been rifled before its owner knew it, often thoughtlessly and without evil intention by those who "just love them."

The destruction of wild flowers not only takes place while they are in bloom but there is another cause which is even worse than picking and that is fire. In early spring, March and April, when the woods are dry and high winds prevail, a match thrown carelessly among the dry leaves will start a fire which soon attains serious proportions and is often difficult to conquer, so that in a short time nothing remains but charred stems and scorched earth from which weeds only can derive sustenance. Fires often result, in the New York Botanical Garden, from the carelessness of smokers, and they always start near the paths.

The same selfish disregard of consequences impels picnic parties to come and scatter unsightly papers, boxes and broken glass, in spite of the fact that according to the city ordinances they are guilty of a misdemeanor and liable for each offence to a fine of from one to five dollars.

These evils are due to thoughtlessness and selfishness; now let us see what fashion is doing. In the July number of the *House Beautiful* occurs the following paragraph:

"The rarest flower in Europe, the edelweiss, is becoming scarcer every year, and unless measures are taken to prevent indiscriminate gathering it is likely to disappear altogether. The edelweiss only grows 2,500 or 3,000 yards above the level of the sea and under special climatic conditions. Unfortunately, the edelweiss has become the 'fashionable' flower in Germany since the Emperor commenced wearing it."

The truth of the matter is that for commercial purposes, the wild supply of edelweiss has long been insufficient and for many years it has been impossible to gather it "indiscriminately," for it is only to be found in the most inaccessible places. But it has long been cultivated for sale to tourists and makers of souvenirs. In fact, the edelweiss is not difficult to grow in suitable localities, and even in unsuitable ones for it, such as the New York Botanical Garden, it has grown and blossomed for two years in succession, in one of the Composite beds of the Herbaceous Grounds, next to its North American allies, the everlastings and cudweeds. The living plants were obtained from the Buffalo Botanical Garden, where it has also been grown, but a succession of hot, dry summers has killed it. In the shaded and moist rock-garden yet to be built it may probably be made to live.

It would be interesting to learn how many boxes of *arbutus* are annually mailed in the United States and how near extermination it is at the several stations where it was formerly abundant. We know that at Lakewood there is little of it left, and we hope that George Gould will protect it within the limits of his estate. It is the only way that certain rare plants and birds have been preserved in England, and we are rapidly finding such restrictions necessary. At Natural Bridge all persons are forbidden picking wild flowers. Various places have their fashionable favorites ; in the Berkshires it is the fringed gentian, in Boston the *Sabbatia*, at several places in Pennsylvania it is the *Rhododendron*, *Kalmia* and *Asalea*, and New York may well claim first place as destroyer of the Holly and *Prinos* berry. We may well ask, also, where will the Christmas trees and greens come from in the future, if they do not cultivate the balsams and spruces, and cease the reckless destruction of ground-pine and laurel. We are sending now to the southern states for most of the holly and mistletoe and to the states northeast of us for Christmas trees.

Before it became the fashion to use "Galaxy" for funeral wreaths, *Galar* was very abundant in the southern Alleghanies, but now that the leaves are picked by the crate-full, it is becoming more expensive. It is to be hoped that they do not "kill the goose that lays the golden egg."

The custom of filling jardinières with ferns has destroyed many pretty nooks in Bronx Park and is the cause of endless trouble, as the propensity to take them and ignore the signs, seems to be a prevalent feminine failing. None of our native ferns are particularly suited to this purpose, however, and invariably need frequent renewing, so that it would be easy to exterminate any one species very soon, if the depredations were permitted and continued. In the heat of summer nothing is more beautiful and restful than a fern bank ; but the sight will not be allowed to New-Yorkers if energetic folk who "must have green things about" have their way. Much care has been taken to transplant into suitably prepared nooks and crevices of the Fern corner, the rarer species and varieties of North American ferns and to surround them with beds of mosses and rocks and shade. The Walking-fern has been exceedingly difficult to establish. There are several stations for this fern within a radius of fifty miles from New

York City, but the stations are kept secret by those members of the "Torrey Botanical Club" who know them, for fear that it will be exterminated. This is the experience of a New England botanist who mourns about her losses in *Rhodora* for March. "We find the 'Walking-leaf'—to use Dr. Bigelow's English name for the *Camptosorus*—but a pretty habit that it has may be the death of it. Growing amongst mosses and other low plants that need but little depth of soil, and whose interlaced roots weave the whole together, it frequently carpets the flat tops of rocks—a beautiful sight which draws the attention even of idle picknickers who, not realizing that they are destroying years of growth, find it amusing to peel off these mats and then, without a pitying thought, throw them on the ground to die. Thus they have laid bare the rocks within sight of their walks; but away from the paths the interesting fern is still common."

In Connecticut the Hartford or Climbing fern was so nearly exterminated for decorative purposes that a law was passed protecting it. We hope that the newly-awakened popular interest in ferns will not lead to the same sad results, but rather cultivate the love of these beautiful plants and help to protect them.

The Natural Science Committee of the Associate Alumnae of the Normal College has been doing a good work, among the children of the East side, in distributing "Nature Material," holding flower-shows in various places and making "loan-collections" for the use of the teachers. We quote from the last Annual Report which reaches 1,500 members.

During the past year the Natural Science Committee has done all in its power to arouse greater interest in Nature Study, especially among the teachers and children of the public schools. With this object in view, the following lines of work have been carried on:

First, the distribution of "nature material" to the Alumnae School Representatives. There have been five of these distributions and the specimens have been as far as possible "according to season," that the children might come into touch with what was going on in the great world of nature, even though obliged to spend their days amid brick and mortar.

October 12, 1900. Fruits and seeds of all kinds, as well as some of the late flowers, as witch-hazel and fringed gentian.

December 7, 1900. Evergreens of many kinds, holly, ground-pine, etc.

January 16, 1901. Birds' nests, cocoons, starfish, sea-urchins, shells, minerals, etc.

February 28, 1901. Budding twigs in great variety, also mosses, lichens, fungi and sea-weeds.

April 16, 1901. Material for aquaria: frogspawn, tadpoles, snails and aquatic plants. A number of maple seedlings in paper pots were also distributed. In a number of instances barrels of labeled specimens have been sent direct to various down-town schools. "About twenty boxes and baskets were sent every week to the ten vacation schools."

"Through the distributions we reach the teachers, but by means of the flower shows we come into direct touch with the children. Last May the experiment was tried of holding a flower show in one of the down-town schools. It proved even more successful than we had anticipated and we hope to make this a permanent branch of our work, as it seems to be more far-reaching in its effects than anything else we undertake. The flowers are *enjoyed*, not only by the children of the school in which the exhibition is held, but by the neighboring schools which are invited to visit the show after school hours; the mothers of the children are asked to come, and if there chances to be a little leisure time the children from the street are invited in."

It is evident from the above quotations that such wholesale quantities as these must be judiciously selected, or there will be no wild flowers left within easy transportation of the city. One member is reported to have sent 150 *pitcher-plants* from a bog at Plymouth, Massachusetts! We question the wisdom of gathering either fringed gentians, pitcher-plants or christmas-fern, in quantities sufficient for distribution to seventy-five teachers, and we hope the pupils of country schools may be guided to make a wise selection, if they are encouraged to send flowers in quantities to the city schools.

The flowers which may be picked in large quantities, without likelihood of extermination are dandelions, violets, daisies, buttercups, black-eyed Susan, wild carrot, clovers, sweet melilot, golden-rod, asters, and grasses innumerable. But the rarer, dainty woodland wild flowers, that fade as soon as they are picked

such as spring-beauties, dogtooth-violets, bloodroot and hepaticas, columbines, anemone, arbutus and pyxie, azalea and laurel, wilk pinks, geraniums and roses and lilies and orchids, dogwood and viburnums, are far better left to reproduce their kind and add new loveliness in new places next year and for many years after. Several times since our connection with the New York Botanical Garden I have stopped children and teachers who were picking flowers or breaking branches of trees, and have been told it was for "nature study" or for "school" and when asked if they did not know it was against the rules of all public parks to pick anything, they almost invariably replied either that they had been in the habit of picking in this place before it became a Park or a Garden and did not see why they should not continue to do so; or they implied that the object for which they were to be used justified the breach of law. The making of loan collections for the teachers is an excellent plan, and the accumulation of local floras at two or three different educational institutions also will help them. For the children, there are the Museums of National History and Botany and the Children's Museum in Brooklyn, but we hope that besides these, we shall have for a long time yet, places near the city, where the wild flowers may be seen growing and that the children of the public schools may not only learn to "*know them by name and enjoy them*," but *leave* them to continue their growth. The greatest destruction of all, comes from the draining, clearing and cultivating of wild lands; and in the vicinity of large cities, by the continued extension of their limits; this, of course, is unavoidable.

The Metropolitan Park Commission of Boston has printed a Flora of the parks within their jurisdiction, compiled by various local botanists who volunteered their services, organizing and coöperating for this purpose. It was published in 1896 and special localities were given for a number of rare plants, among them *Pogonia verticillata*, *Habenaria fimbriata*, *Epigaea repens*, *Kalmia latifolia* and *Conopholis Americana* and in the preface we find the following references to them: "The public should be exhorted, if they come across such plants as these, to preserve them rigidly. The true botanist and lover of nature needs no such exhortation."

It would be interesting to know, whether any injurious results

have followed its publication, or whether the Boston public has reached such a high degree of culture both moral and aesthetic that no one makes an exception even of himself?

But the climax has been reached in an advertisement which has been printed in *Rhodora*, the Journal of the New England Botanical Club, since May. It announces that on the Bangor and Aroostook Railroad, there is to be had the "best botanizing in the Eastern States," and proceeds to give the names of stations and lists of rare plants to the length of two whole pages. We ask with amazement, where did they get the information? What botanist sold his birthright for a few railroad passes? Fortunately, many of the plants listed are so rare that only the discriminating and trained botanical specialist will be sure to find them, and the general public will hunt a long time and not know them when they see them.

Mr. Redfield used to tell the story of Rafinesque that when he first found *Corema Conradii*, he threw himself down upon it and stretching out his arms, said "all that I cover is mine." It is not always the most enlightened who are the most unselfish. There have been botanists, even in the Torrey Club, who uprooted plants wantonly and made no good use of them after they were picked. But the custom of carrying "tin trunks" has been largely superseded by presses, and only a few duplicates are now made of each species.

The flora of Great Britain is, perhaps, the best known of any in the world; and there is more knowledge among the working people of special and difficult branches of botany, probably than in any other country, Germany not excepted. Dr. Braithwaite told me that he had sold a great many copies of the *British Moss-flora* to the Manchester weavers.

But many of their rarest plants have been exterminated by botanists, as shown by the following quotations taken from the *Journal of Botany* for July :

"The accuracy in general matters for which the *Daily Mail* has long been conspicuous, extends to its botanical information. We reproduce the most recent item in the hope that the publicity now given to the methods of the 'professional botanist' will cause him to abstain from this nefarious means of adding to his income.

"Four of the daintiest of English wild plants are rapidly dis-

appearing from this country, and one, at any rate, can rarely be seen outside Kew gardens. This is the *Cypripedium Calceolus* commonly known as the 'lady's slipper.' It is really a wild orchid, with a pretty yellow flower resembling in shape the article which has given it its popular name. The other vanishing plants are the *Osmunda regalis*, the *Scolopendrium vulgare* (hart's tongue), and the *Asplenium viride* (green spleenwort), all of which are ferns. Their disappearance is due to the depredations of the tourist, especially of the cyclist, and the professional botanist, who scours the woods and disposes of his 'finds' for a few pence in the streets of the nearest large town."—*Daily Mail*, June 26.

"There can, however, be little doubt that, apart from the ravages of 'professional botanists' and the destructive efforts of various local bodies, who throughout the country are engaged in destroying grassy roadsides and scarifying hedgebanks, to the great advantage of the nettles, docks and other weeds which take the place of the native vegetation, our British plants are threatened with a new danger."

"I have before me the programme of the Essex Technical Instruction Committee for Field Studies in Natural History. The course for 1901 is intended to instruct teachers in the elements of botany by means of rambles in search of wild flowers. One leading feature is a vacation course of ten days in the New Forest. The teachers are to be accompanied by local guides, and their attention is particularly directed to the rarest species, which are specially named, as well as the places in which they are known to grow. To collect, dry and identify plants is the chief aim of the leaders, who not only urge every teacher to make his own collection, but suggest that duplicate plants will prove useful for 'special fascicles.' It seems to me lamentable that teachers should be advised to study natural history by schedules, and to gather plants merely in order to name and dry them. I imagine that they will be worse and not better for working through so dry and barren a course. Nothing shows the want of judgment of the promoters more clearly than that untrained botanists should be seriously advised to pay particular attention to the difficult and uncertain subspecies of the common bramble. But all of us, whether we are concerned with the teaching of botany or not, have an interest in the preservation of

our native plants. The Essex Committee is simply organizing a raid upon plants which are already near to extinction. I hope that they will fail to discover the rarities which they selfishly covet; their enterprise is, I venture to say, an injury to natural history and to education alike. It may not be too late to get this programme cancelled, and I would beg those who care for live natural history to use their influence in diverting the attention of the Essex collectors to some other pursuit where they will do less harm."

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 17

THE TYLOSTOMACEAE OF NORTH AMERICA

BY V. S. WHITE

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The Tylostomaceae of North America

BY V. S. WHITE

(WITH PLATES 31-40)

The members of this family are puffball-like plants, which form underground in the shape of rounded masses, appearing at first on the mycelium as minute thickenings, and gradually reaching their full development. The ball has a thick outer covering, and an inner, and usually thinner one, commonly known as the peridium proper. The upper and larger portion of the ball is composed of sporogenous tissue, and there is a lower sterile portion which elongates when conditions are most favorable, forcing the upper portion up through the surface of the ground, and consequently rupturing the outer coat which originally enveloped the whole mass. In some genera this outer coat remains at the base as a distinct cup-like volva, the upper portion then being carried up almost intact and falling away or adhering to the peridium; in other cases the outer coat is ruptured irregularly, bearing very slight traces at the base of the stem or even none at all, and in the genus *Tylostoma* this coat adheres more or less to the peridium, nearly always leaving some traces in the form of a collar at its base. The stem is commonly of a firm, almost woody texture, and the plants can be quite satisfactorily preserved in a dry condition. They vary greatly as to size and shape, but are all constructed on the same general plan, having a more or less irregularly globose peridium, and a distinct footstalk, which is usually, though not always, more than twice the length of the peridium in mature forms. The methods of

dehiscence are very different in the various genera, some having a definite apical mouth, the peridium withering and collapsing as the spores escape; others rupture irregularly from above downwards, more as in the Sclerodermataceae. *Battarreia* has a regular line of dehiscence where the upper portion of the somewhat hemispheric peridium breaks away, leaving the lower portion at the summit of the long stem.

In the peridial characters, *Tylostoma* is closely allied to the Lycoperdaceae. The relation of this family to the Phallaceae is one of analogy mainly, shown in the elongation of the stem which forces the spore-bearing parts to a higher position for the better scattering of the spores.

In his latest treatment of the family, Fischer* recognizes four genera: *Tylostoma* with forty species, widely distributed; *Queletia* with a single species from France, failing to note that it had also been reported from America; *Battarreia* with eight species; and *Sphaericeps* with one species from Angola. The genus *Chlamydopus*, described by Spegazzini† from Argentina, after Fischer's first draft was prepared, was later too summarily assigned as a synonym of *Tylostoma*,‡ for the differences are so marked that it would be unfortunate to include these two diverse types under one genus.

Within the past year several specimens of a *Chlamydopus* have been found at Mesilla Park, New Mexico, and it was the original purpose of this paper simply to describe and figure these. It soon became necessary to study the members of the allied genus *Tylostoma*, of which extensive suites of specimens were found in the Ellis collection, mainly from the western half of the country, representing some species hitherto undescribed, so that it was finally concluded to prepare a revision of the entire family as represented in North America. Finally some specimens collected by Mr. E. Bethel, of Denver, Colorado, and sent by him to Mr. Ellis, proved to belong to an undescribed genus. This large amount of material, mostly forming a part of the Ellis collection at the New York Botanical Garden has made the preparation of this paper

* Engler & Prantl, Die nat. Pflanzenfam. 1¹*: 342. 1900.

† An. Mus. Nac. Buenos Aires, 6: pl. 4. f. 2, 3. 1899.

‡ Engler & Prantl, Die nat. Pflanzenfam. 1¹*: 357. 1900.

possible. Mr. E. Bartholomew has kindly loaned material, for the better description of one species, and Mr. E. S. Salmon has kindly looked up some data at Kew, England.

Special thanks are due to Professor Charles H. Peck, of Albany, for material and suggestions, and more especially to Professor L. M. Underwood, of Columbia University, under whose direction the work has been undertaken and whose private collection has furnished considerable additional material.

The genera of the family Tylostomaceae may be recognized by the following synopsis:

Peridium opening by an apical mouth.

Peridium with a collar underneath, formed about the cylindrical stem; volva indefinite. I. TYLOSTOMA

Peridium without a collar; stem much enlarged where it joins the peridium; volva cup-like, flaring. II. CHLAMYDOPUS

Peridium circumscissile.

Peridium hemispheric or nearly plane below, dehiscing at the margin of the plane of the hemisphere. III. BATTARREA

Peridium spherical, dehiscing at the equator. SPHAERICEPS (extra-limal).

Peridium opening irregularly.

Peridium readily separating from the stem; capillitium free.

IV. QUELETIA

Peridium closely attached to the stalk; capillitium embedded in a membranous tissue. V. DICTYOCEPHALOS

I. TYLOSTOMA Pers. Römer, Neues Mag. Bot. 1: 86. 1794

The first reference to a plant certainly belonging to *Tylostoma*, is to be found as early as 1696, in Ray's Synopsis * under the name of *Fungus pulverulentus minimus*. He describes it in a few Latin words, "Pediculo longo, insidens. In agris circa Londinum," and adds in English, "the least dusty mushroom, with a long foot-stalk, collected by D. Tancred Robinson, M.D." The next mention is made in 1700 by Tournefort † who also gives the first figure of a *Tylostoma*; this has the characteristic short tubular mouth of *T. pedunculatum*, a slender, smooth stem, and closely resembles specimens of this plant found in our own country. Micheli ‡ next figured the other variety of *T. pedunculatum* under the name, *squamosum*. This figure is not so easy to identify as that of Tournefort;

* Syn. Meth. Stirp. Brit. 2d ed., 16. 1696.

† Inst. rei Herb. 1: 563. pl. 331. f. E, F. 1700.

‡ Nova Plantarum Genera, 218, nos. 10 and 11. pl. 97. f. 1. 1729.

none of the European specimens of this variety seen, have such a rough stem, or a peridium of the exact shape as shown in the figure, but it is evident notwithstanding, what it was meant to represent. *T. pedunculatum* being the commonest European species, and widely distributed tends to vary and extreme specimens are found to differ so widely that were it not for the many intermediate stages, the extremes might well be kept distinct, as indeed has been done by several writers.

Linnaeus* refers to this same plant by its first binomial, *Lycoperdon pedunculatum*, and cites the above-mentioned descriptions of Ray and Tournefort. His description is in the following words: "Stipite longo, capitulo globoso glabro; ore cylindrico, integerrimo. Habitat in campestribus." In 1794 Persoon established the genus *Tylostoma*.† He described it—"Peridium stipitatum, ore cylindrico cartilagineo"—and mentions two species *T. brumale* (*L. pedunculatum* L.) and *T. imbricatum* (Micheli Ly. 11); these two species have since been commonly referred to, under the name of *T. mammosum* (Mich.) Fries, but all these specific names are antedated by *pedunculatum* of Linnaeus.

Since the time of Persoon, various species of *Tylostoma* have been described, and De Toni‡ enumerates thirty-four species from different parts of the world.

Our own species were studied in 1890 by Morgan,§ but evidently from a limited amount of material. In his paper he enumerates five species, of which *T. mammosum* and *T. fimbriatum* are originally European, two were new native species, *T. verrucosum* and *T. campestre*, and the fifth he called *T. Meyenianum* Kl., but it is evident that the original *T. Meyenianum* was not a true *Tylostoma* but a poorly figured species of the genus *Chlamydopus*, and as the material on which Morgan based his determination is not now available, we are uncertain as to what his last species really is. *T. pedunculatum* was first reported from this country in 1818 by Schweinitz|| under the name

* Sp. Plant. 1184. 1753.

† *Tylostoma* from *τυλος*, callous skin, and *στομα*, a mouth.

‡ Saccardo, Syll. Fung. 7: 60; 9: 268; 11: 159; 14: 258.

§ Jour. Cin. Soc. Nat. Hist. 12: 163; pl. 16. f. 1-5. 1890.

|| Syn. Fung. Car. 34. 1818.

of *T. brumale* Pers. from North Carolina, and in 1834* he gives two species, *T. brumale* and *T. squamulosum*,† of which latter he writes "not a variety of the preceding but closely resembling *Rinella* of Rafinesque,‡" but notwithstanding his assertion to the contrary *T. squamosum* is now commonly regarded as a variety of *T. pedunculatum* (*brumale*). In 1837, Montagne§ described *T. exasperatum* from Cuba, collected by Ramon de la Sagra, the well-known Cuban naturalist, and this species has since been reported from India. In 1867 Curtis¶ mentions *T. fimbriatum* and *T. mammosum* as "common in North Carolina," and six years later Berkeley** reported *T. fimbriatum*, *T. mammosum*, and *T. Meyenianum*, collected by Wright in New Mexico. As late as 1891, Masee†† published Berkeley's description of *T. Wrightii*, also from New Mexico. Other American species have been described since, *T. obesum* C. & E., ‡‡ *T. punctatum* Peck, §§ and *T. semisulcatum* Peck. ¶¶ Much of the western material found in the Ellis collection had been referred to *T. obesum*, although it represents very diverse forms. *T. punctatum* has been reported from several localities, but of *T. semisulcatum* only the type specimens are known, and these are inaccessible at Albany, if indeed they are still in existence. Extensive collections have been made in different parts of the United States in the past few years and we

* Trans. Amer. Phil. Soc. 4: 256. 1834.

† Since writing the above it has been possible to examine Schweinitz' original specimens, which are carefully preserved in the Philadelphia Academy of Natural Sciences. There is a question as to the specimen marked *T. brumale* being *T. pedunculatum*, to which it is usually referred, owing to the color of the peridium, which is a bright terra-cotta red, unlike anything seen before—but this may be due to the color of the clay in which the plant grew or to other causes of unknown origin. The specimen marked *T. squamosum* resembles greatly some of our specimens of *T. fimbriatum* in general habit and spore characters, with the exception of the mouth which is entire, but not tubular and prominent, like the mouth of *T. pedunculatum*—which fact may be owing to the wasting of the cartilaginous tissues occasioned by time—so that it is hardly possible to determine what this plant really was.

‡ Syst. F. Veg. 139.

§ Ann. Sci. Nat. II. 8: 362. 1837.

¶ Geol. and Nat. Hist. Survey North Carolina, 3: 110. 1867.

** Grevillea 2: 49. 1873.

†† Grevillea 19: 95. 1891.

‡‡ Grevillea 6: 82, pl. 100. f. 24. 1878.

§§ Bull. Torr. Club, 23: 419. 1896.

¶¶ Bull. Torr. Club, 22: 209. 1895.

find among them several additional species. The indications are that we are only at the beginning of our knowledge of their distribution.

The following table shows the distribution of the hitherto known species of *Tylostoma* :

TYLOSTOMA.	North America.	South America.	Europe.	Asia.	Africa.	Australia.	Mexico and Central America.	Borneo.	Sandwich Islands.
album.						+			
Angolense.				+	+				
Barlae.			+	+					
Barbeyanum.				+					
Berteroanum.		+							
Bonianum.				+					
Bossieri.					+				
campestre.	+								
caespitosum.				+					
carneum.					-				
Cesatii.				+					
exasperatum.	+			+					
fimbriatum.	+		+	+		+			
Giovanellae.			+						
granulosum.			+						
Jourdani.					+				
laceratum.					+				
leprosum.						+			
Leveilleanum.									+
mammosum.	+		+	+	+	+	+		
maximum.						+			
Mollerianum.					+				
montanum.					+				
obesum.	+								
pulchellum.					+				
pusillum.		+						+	
Patagonicum.		+							
Schweinfurthi.					+				
squamosum.					+				
tortuosum.					+				
volvulatum.				+					
verrucosum.	+			+					
Wightii.									
Wrightii.	+								

The species of *Tylostoma* are found principally in sandy regions, in dry barren fields, rarely in woods or shaded places. As yet very little is known of their habits, growth and development as no little difficulty attends the study of these strange and interesting plants in their early subterranean stages. It is hoped that stu-

dents in the districts where these plants are most common will gather material in the earlier stages of growth—digging down where mature forms are found above ground in the hope of finding the young peridia.

As far as can be ascertained, only two papers have appeared treating of the growth of these plants. Schroeter * has published an account of the development of the spores and basidia. Professor Bessey † has a short note on the growth of *T. mammosum* in which he says, "The ball forms underground, and reaches maturity there so far as the spores are concerned. *Tylostoma* agrees with *Lycoperdon* in having the interior of the ball composed of two portions, first a spore-bearing part which occupies most of the interior, and second a sterile base composed of tissue which does not produce spores. In *Tylostoma* a portion of this tissue of the sterile base remains living until the spores ripen. Then this tissue begins a rapid growth and a cylindrical stalk is produced which forces the ball through the overlying earth and carries it up several inches." Masee, ‡ speaking of *Tylostoma mammosum* says, "resembling a *Lycoperdon* with an elongated stem, but readily distinguished by the groove between the apex of the stem and the peridium, and by the threads of the capillitium being nodulose at the base of the septa." And writing of the stem, "it is sometimes smooth, and at others broken with small irregular fibrillose squamules which are sometimes arranged more or less in circles."

Synopsis of our Species

Mouth entire, short tubular.

Spores smooth, or occasionally with a few minute scattered warts.

1. *T. albicans*.

Spores uniformly and densely verrucose.

Peridium smooth; capillitium not much swollen at the joints.

2. *T. pedunculatum*.

Peridium warty; capillitium swollen at the joints.

3. *T. verrucosum*.

Mouth lacerate-fimbriate, not tubular.

Spores smooth or nearly so.

Mouth plane.

Stem tapering toward the base; peridium depressed.

4. *T. gracile*.

* Cohn's Beitr. Biol. Pfl. 2: 65. 1877.

† Amer. Nat. 21: 665. 1887.

‡ Ann. Bot. 4: 85. 1889.

- Stem not tapering; peridium globose.
 Capillitium freely septate; stem short (1-1.5 cm.), collar close.
 5. *T. minutum*.
- Capillitium rarely or never septate; stem longer (1.5-5 cm.), collar distant.
 6. *T. Kansense*.
- Mouth raised, convex.
 Capillitium freely septate; outer peridium long persistent.
 7. *T. poculatum*.
- Capillitium rarely or never septate; outer peridium soon receding.
 8. *T. obesum*.
- Spores verrucose or granular.
 Mouth plane.
 9. *T. campestre*.
- Mouth raised, convex.
 Spores furnished with long blunt spinules; stem short (0.75 cm.), rough spiny.
 10. *T. exasperatum*.
- Spores with coarse scattered tubercles; stem longer (3 cm.), even, nearly smooth.
 11. *T. tuberculatum*.
- Spores finely granulate-verrucose.
 Capillitium sparingly septate, not much swollen at the joints.
 Stem elongate (6 cm.), with copious persistent mycelial strands.
 12. *T. fibrillosum*.
- Stem shorter (3.5 cm.), without mycelial strands.
 13. *T. subfuscum*.
- Capillitium freely septate, swollen at the joints.
 Peridium smooth; mouth fimbriate.
 14. *T. fimbriatum*.
- Peridium pitted; mouth lacerate.
 15. *T. punctatum*.

1. *Tylostoma albicans* sp. nov.

Peridium depressed globose, 0.7-1 cm. high, 1-1.5 cm. in diameter: outer peridium scaly, retreating and leaving a smooth whitish surface to the inner membranaceous peridium: mouth short tubular, entire, prominent: collar irregular, 3-5 mm. distant from the stem: stem equal, slightly thickened at the base, the outer coating lacerate scaly, whitish like the peridium, 4-6 cm. long, 0.5 cm. in diameter: capillitium whitish, hyaline, branched, septate, slightly swollen at the joints, 4-6 μ wide, free ends rounded: spores reddish brown, irregularly globose, pedicled, smooth, or if rough only a very few of them so, 4-5 μ in diameter. (Pl. 31, f. 4-7.)

TEXAS: *E. D. Cope*.

2. *TYLOSTOMA PEDUNCULATUM* (L.) Schroeter; Cohn, Beitr. Biol. Pfl. 2: 65. 1877

Lycoperdon pedunculatum L. Sp. Pl. 1184. 1753.

Tulostoma brumale Pers. Römer Neues Mag. Bot. 1: 86. 1794.

Tulostoma mammosum Fr. Syst. 3: 42. 1829.

Lycoperdon II. Mich. Nov. Plant. Gen. 218. 1729.

Tulostoma imbricatum Pers. Römer Neues Mag. Bot. 1: 86.

1794.

Lycoperdon squamosum Gmel. Syst. Nat. 2: 1462. 1796.

Tulostoma squamosum Pers. Syn. Meth. Fung. 139. 1801.

Tulostoma mammosum Fr. Syst. 3: 42. 1829.

Tylostoma mammosum var. *squamosum* De Toni; Saccardo, Syll. Fung. 7: 61. 1888.

Peridium subglobose, 1-1.5 cm. high, 1-2 cm. in diameter, the brown outer peridium soon retreating, leaving the inner peridium smooth and membranaceous: mouth short tubular, entire, prominent: collar inconspicuous: stem slender, lacerate scaly, or nearly smooth, with a small mycelial bulb, stuffed with loose silky threads, 1-5 cm. long, 2.5 mm. in diameter: capillitium 4-7 μ thick, septate, somewhat swollen at the joints, light colored, hyaline: spores subglobose, 3-5 μ in diameter, minutely verrucose, some short pedicled. (Pl. 31, f. 1-3.)

Exsicc. E. & E. N. A. Fungi 2734 (as *T. mammosum*). Ravenel, Fungi Am. Ex. 137 (as *T. mammosum*).

NEW YORK, *Underwood, Fischer*; NEW JERSEY, *Ellis*; PENNSYLVANIA; MICHIGAN, *McBride*; WISCONSIN, *D. V. B.*; NORTH CAROLINA, *Curtis, Wood*; KANSAS, *Kellerman*, 770; INDIANA, *Cook, Underwood*; FLORIDA, *Underwood*; NEBRASKA, *Webber*; TEXAS, *Harris*; COLORADO; IOWA; NEW MEXICO, *Wright, Fendler, Cockrell*; MEXICO, *C. L. Smith*.

3. TYLOSTOMA VERRUCOSUM Morg. Jour. Cin. Soc. Nat. Hist. 12: 163. pl. 16. f. 2. 1890

Peridium depressed globose, 1-1.2 cm. high, 1-1.5 cm. in diameter: outer peridium of scales and warts persistent: inner peridium brownish, becoming smooth with age: mouth entire, raised, prominent, short tubular: collar of delicate lacerate points descending about the top of the stem: stem 4-5 cm. long, .5 cm. in diameter, slender, the surface lacerate scaly, brown, hollow, cylindrical and having a large basal bulb composed of the mycelial strands and adherent earth: capillitium almost white, hyaline, slender, septate, some of the joints rather swollen, 3-6 μ wide: spores subglobose, granular, lightish cinnamon-colored, 4-7 μ in diameter. (Pl. 31, f. 8-10.)

OHIO: *Morgan, C. G. Lloyd*.

Growing on the ground in rich soil in woods. The mycelial bulb is usually larger than the peridium.

4. *Tylostoma gracile* sp. nov.

Peridium depressed globose, 1-1.5 cm. high, 1.5-2 cm. in diameter: outer peridium retreating, leaving but slight traces on the inner peridium which is thin, smooth, whitish and rather shiny: mouth plane, lacerate: collar entire, restricted around the top of the stem: stem slender, 3-5.5 cm. long, 6 mm. in diameter at the top, 3 mm. in diameter at the base which is slightly enlarged, somewhat sulcate, lacerate, whitish within and without, fibrillose stuffed, becoming hollow: capillitium dark ferruginous, 4-6 μ wide, ends rounded, and having swollen places mostly near the ends, branched, rather thick-walled, many threads flattened, septa very scarce: spores subglobose, 3-5 μ in diameter, smooth, short pediceled. (Pl. 32, f. 1-3.)

NEW MEXICO: Las Cruces, *Wooton*.

5. *Tylostoma minutum* sp. nov.

Peridium globose, 0.7-1 cm. high, 0.7-1.2 cm. in diameter; outer peridium scaly, retreating, leaving smooth, brownish surface to the thin inner peridium, remnants of the outer peridium forming a cup around the base of the inner peridium: mouth plane, fimbriate, small; collar entire, indistinct: stem 1.5-2 cm. long, 3 mm. in diameter at the top, 5 mm. in diameter at the base, slender, slightly enlarged at the base, hollow, fibrillose stuffed: capillitium yellowish, hyaline, sparingly branched, rather thin walled, ends rounded, septa swollen at the joints, 3-5 μ wide: spores irregularly globose, nearly smooth, pediceled, thick-walled, 3-5 μ in diameter. (Pl. 31, f. 11-13.)

COLORADO, *Bethel* (type); KANSAS, *Kellerman*.

6. *Tylostoma Kansense* Peck, sp. nov.

Peridium subglobose, 1-2 cm. broad, 1-1.5 cm. high, thick, firm, glabrous, white, somewhat flattened at the base: mouth slightly lacerate on the margin, plane, sometimes slightly prominent: collar wide, membranaceous, 2.5 mm. distant from the stem: stem equal or slightly narrowed toward the base, 1.5-7 cm. long, 6-8 mm. thick, hollow or stuffed with silky fibrils, somewhat sulcate-striate, white within and without, slightly and abruptly bulbous: capillitium sparingly branched, colored, 7-11 μ wide, hyaline, septa not seen: spores subglobose, 4-5 μ in diameter, brownish ferruginous. (Pl. 32, f. 7-9.)

KANSAS, *Bartholomew*. July. It has rarely two ostiola.

7. *Tylostoma poculatum* sp. nov.

Peridium globose, somewhat depressed, 1–1.5 cm. high, 1–2 cm. in diameter, smooth, fawn-colored, membranaceous: outer peridium scaly, but more persistent than in most species, remaining in the shape of a cup-like involucre round the base of the peridium, mouth slightly raised, fimbriate, mostly large: collar entire, inconspicuous: stem 1–3 cm. long, 3–6 mm. in diameter, cylindrical, firm, slightly bulbose, hollow or stuffed, often with considerable remnants of the outer peridium attached: capillitium lightish yellow, sparingly branched, septate, swollen at joints, 4–7 μ wide, rather thick walled: spores ferruginous, subglobose, smooth, or irregularly ridged in the older specimens, owing to the shrinking of the inner substance, short pediceled, 4–5 μ in diameter. (Pl. 34, f. 4–6.)

NEBRASKA: Lone Pine, *Bates*, 462 (type); ALABAMA: Tuskegee, *Carver*; COLORADO: Boulder, *D. M. Andres*. Plants growing singly or in groups of twos and threes.

8. TYLOSTOMA OBESUM C. & E. *Grevillea* 6: 82. *pl.* 100. *f.* 24.

1878

Peridium globose pyriform, 2.2 cm. high, 2 cm. in diameter, smooth, leathery, whitish, with a kid-like finish: outer peridium scaly, retreating, leaving a narrow ring around the lower part of the peridium: collar entire, descending about the stem: mouth raised, lacerate, rather large: stem 4 cm. long, hard, leathery, somewhat sulcate, slightly tapering at the base, 8 mm. in diameter at the top, 5 mm. in diameter at the base: capillitium dark ferruginous, slender, free ends rounded, branched, septa none or very scarce, 3–6 μ wide: spores globose, smooth, short pediceled, 3–6 μ in diameter. (Pl. 32, f. 4–6.)

COLORADO.

This description and the figure are based on the specimen of this species which Mr. Ellis retained when he sent other specimens to M. C. Cooke for a description. It will be seen that the dimensions and shape here given differ considerably from the one figured in *Grevillea*. The type is at Kew (2715 Cke.), and through the kindness of Mr. E. S. Salmon, it was possible to compare some of the spores and capillitium which agree in all respects with the original here, but the Kew specimens are apparently not so mature.

9. TYLOSTOMA CAMPESTRE Morg. Jour. Cin. Soc. Nat. Hist.

12: 163. *pl. 16. f. 4.* 1890

Peridium subglobose, 1–1.5 cm. high, 1–2 cm. in diameter: outer peridium brown, scaly, retreating and leaving an irregular ring around the lower part of the smooth inner peridium: collar irregular, descending about the top of the stem: mouth plane, lacerate, in some specimens being a mere crack or slit: stem rather thick, 3–10 cm. long, 1–1.5 cm. in diameter, darker than the peridium, fibrillose stuffed, becoming hollow, outer brownish coat lacerate, scaly, and having a small thickened mycelial bulb: capillitium yellowish, hyaline, cylindrical, 4–8 μ wide, branched, septate, somewhat swollen at the septa: spores subglobose, warty, some short pedicled, 3–5 μ wide. (Pl. 33, f. 10–12.)

EXSICC: E. & E. N. A. Fungi, 3297 (as *T. granulosum* Sw. ?), 3514.

NEBRASKA: *Webber, Bates*; CALIFORNIA: *Underwood, McClatchie*; COLORADO, *Crandall*. Growing singly and in groups in sandy soil.

10. TYLOSTOMA EXASPERATUM Mont. Ann. Sci. Nat. II. 8: 362.

1837

Peridium subglobose, 1.2 cm. high, 1.3 cm. in diameter: outer peridium composed of long spinulose scales, somewhat reflexed, which recede from the top downward, leaving the brown inner peridium marked with a series of regular pits: mouth raised, fimbriate lacerate, rather large: collar inconspicuous: stem equal, slightly enlarged at the base, 5–7 mm. in diameter, 3.5 cm. long, covered with reflexed lacerate scales, like those on the outer peridium: dark brown: capillitium whitish-yellow, hyaline, 4–6 μ wide, branched, free ends rounded, sparingly septate, not much swollen at the joints: spores globose, furnished with long blunt spinules, 5–8 μ in diameter. (Pl. 33, f. 1–3.)

CUBA, *Wright*.

11. *Tylostoma tuberculatum* sp. nov.

Peridium depressed globose, 1–1.2 cm. high, 1–1.8 cm. in diameter: outer peridium scaly, retreating, leaving a wide band around the base of the whitish, smooth, and rather thin, inner peridium: mouth raised, fimbriate, roundish: collar close, inconspicuous: stem slender, whitish, hollow or stuffed, slightly enlarged at the base, 2–3 cm. long, 3 mm. in diameter: capillitium light yellow, hyaline, branched, thick-walled, variable as to width, 4–8 μ wide, rather flattened, ends rounded, broad, sparingly sep-

tate, swollen at joints: spores subglobose, nearly smooth or with occasional tuber-like warts, thick-walled, $3-5\ \mu$ in diameter. (Pl. 33, f. 7-9.)

BRITISH COLUMBIA: *Macoun* (type); COLORADO: Fort Collins, *Baker*, 405.

12. *Tylostoma fibrillosum* sp. nov.

Peridium globose, 1-2 cm. high, 1-2.5 cm. in diameter: outer peridium retreating leaving a smooth whitish surface to the thin, membranaceous inner peridium, and leaving a thick portion round the base of the peridium forming a ring: collar indistinct, close: mouth raised, fimbriate, roundish: stem equal or slightly tapering toward the base, sulcate, firm, white and slimy within and without, somewhat hollow, fibrillose stuffed, and having a small thickened bulb which in some specimens falls off leaving a flat, whitish surface to the base of the stem, 5-7 cm. long, 5 mm. in diameter: capillitium whitish, hyaline, $4-8\ \mu$ wide, branched, some threads rather thickened walled, sparingly septate, not much swollen at the joints, rather flattened: spores subglobose, minutely warted, darker than the capillitium, some short pediceled, $3-5\ \mu$ in diameter. (Pl. 33, f. 4-6.)

ONTARIO: *Dearness* (type); MICHIGAN, *Hicks*. Growing on sand dunes.

The stem is much covered usually for upwards of 2 cm. with the mycelial strands, and adhering sand. The specimens from Michigan have rather more swollen septa.

13. *Tylostoma subfuscum* sp. nov.

Peridium globose, 0.8-1.3 cm. high, 1-1.5 cm. in diameter: outer peridium scaly, retreating, leaving a ring around the base of the smooth, brownish inner peridium: mouth raised, fimbriate: collar inconspicuous, close: stem brown, somewhat lacerate scaly, leathery, sulcate, with a small thickened bulb at the base, 2-3 cm. long, 3-5 mm. in diameter; capillitium lightish yellow, hyaline, branched, threads long and slender, $4-6\ \mu$ wide, free ends rounded, occasionally septate, somewhat swollen at the joints: spores subglobose, minutely warted, some short pediceled, $3-5\ \mu$ in diameter. (Pl. 34, f. 10-12.)

COLORADO, *Bethel*, 21.

14. *TYLOSTOMA FIMBRIATUM* Fries, Syst. Myc. 3: 43. 1829

Peridium subglobose, 1-1.5 cm. high, 1-1.5 cm. in diameter: outer peridium retreating, having a smooth, brownish surface to

the thin inner peridium : mouth raised, fimbriate, collar irregular, inconspicuous, close : stem white within and fibrillose stuffed, brownish and lacerate scaly outside, with a small mycelial bulb at the base, 1.5–5 cm. long, 5 mm. in diameter : capillitium light-colored, almost white, hyaline, freely septate, swollen at the joints, 4–8 μ wide : spores subglobose, dark ferruginous, verrucose, some short pediceled, 3–6 μ in diameter. (Pl. 34, f. 7–9.)

EXSICC. : Ravenel, Fungi Car. Ex. 5 : 80 ; Ravenel, Fungi Am. Ex. 724.

NEW YORK, *Peck* ; SOUTH CAROLINA, Ravenel ; NORTH CAROLINA, *Curtis, Wood* ; ALABAMA, *Earle* ; TEXAS, *Wright* ; WYOMING, *Nelson* ; NEW MEXICO, *Wright* ; COLORADO, *Cockerell* ; KANSAS, *Kellerman*.

15. TYLOSTOMA PUNCTATUM Peck, Bull. Torr. Club, 23 : 419. 1896

Peridium subglobose, 1–1.3 cm. high, 1–1.3 cm. in diameter : outer peridium scaly, retreating, leaving a ring around the base of the peridium : inner peridium thin, whitish, covered with irregular shallow pits : mouth raised, lacerate, irregular, rather large : collar indistinct, close : stem equal, darker than the peridium, lacerate scaly, with a small mycelial bulb, white within, hollow or stuffed, 2–3 cm. long, 3 mm. in diameter : capillitium whitish, hyaline, branched, septate, much swollen at the joints, 4–8 μ wide : spores subglobose, yellowish cinnamon-colored, minutely verrucose, some short pediceled, 3–5 μ in diameter. (Pl. 34, f. 1–3.)

KANSAS, *Bartholomew* ; NEBRASKA, *Webber* ; WASHINGTON, D. C., *Braendle*. Growing in sandy pasture land.

SPECIES NOT SEEN

16. TYLOSTOMA SEMISULCATUM Peck, Bull. Torr. Club, 22 :

209. 1895

“Peridium subglobose, usually a little longer than broad, 6–8 lines broad, 9 lines long, glabrous above, ferruginous-tomentose on the lower half : ostecolum entire : stem equal, about 2 inches long, even and glabrous or but slightly furfuraceous on the upper part, the lower part longitudinally sulcate, whitish : spores ferruginous, globose, .00016 to .0002 in. broad : threads of the capillitium not septate.

“Sandy soil, Nevada. Collected by C. W. Irish, communicated by T. Taylor.

“This species is separated from *T. mammosum* Fr. by its peri-

dium, which is tomentose on the lower half and not depressed, and by its stem which is distinctly furrowed on the lower half."

As this species was not seen the above original description is quoted. The same is the case with the following description of *T. Wrightii*, and the species which Morgan calls "*T. Mcycnianum*." It has been thought best to include these descriptions in order that our present knowledge of the group may be accessible in a single paper.

17. TYLOSTOMA WRIGHTII Berk. Grevillea, **19**: 95. 1891

"Stem 6 cm. high, 4 mm. thick, hollow, equal, ochraceous, even, glabrous; peridium spherico-depressed, 2 cm. broad, minutely umbonate, pale, ochraceous, glabrous, the wall of the umbo disappears at maturity and forms a small circular stoma; mass of spores yellowish brown; threads of capillitium hyaline, thick-walled, aseptate, equal, very long, branched, axis lunate, 5 μ in diameter: spores glabrous, globose, pale yellow brown, minutely warted, 5-6 μ in diameter.

"On the ground. Rio Grande, North * Mexico (Wright). Type in Herb. Berk.

"Distinguished from *Tulostoma Mcycnianum* in the entire mouth and the hollow, even and not striated stem."

TYLOSTOMA sp. (Described by Morgan, Jour. Cin. Soc. Nat. Hist. **12**: 163. *pl. 16. f. 5*, as *T. Mcycnianum* Kl., but it is clearly distinct from that species, though it might possibly be referred to *T. obesum* C. & E.)

"Peridium depressed, globose; the cortex soon receding, leaving a smooth whitish or yellowish surface to the submembranaceous inner peridium, the apex plane with a lacerate mouth: stipe long, thick, unequal, fusiform or tapering, nearly solid, sulcate: threads of the capillitium long, much thicker than the spores, branched, hyaline: spores subglobose, even, pale brown, 4.5-5.5 mic. in diameter.

"Growing in sandy soil. New Mexico, *Wright*; Colorado, *Webber*. Plant 2-4 inches in height, the peridium $\frac{3}{4}$ -1 inch in diameter, the stipe about $\frac{1}{2}$ of an inch in thickness at the thickest part. Specimens referred to *T. Angolense* W. & C. do not differ otherwise than in having the stipe thickest at the apex and taper-

* Probably a misprint for *New* as Wright was not known to have collected across the Rio Grande.

ing downward instead of fusiform. *T. obesum*, C. & E. appears to be founded on a specimen with the short thick stipe not fully developed."

Morgan's description was made solely from Webber's Colorado specimen which was returned to Mr. Webber who is now unable to find it. The New Mexican reference is merely a quotation from Berkeley who determined Wright's original specimens under this name.

The following tabulation will give more compactly our present knowledge of the distribution of *Tylostoma* in North America :

TYLOSTOMA.	New York.	New Jersey.	Pennsylvania.	N. Carolina.	S. Carolina.	Alabama.	Florida.	Texas.	New Mexico.	Arizona.	California.	Nevada.	Colorado.	Nebraska.	Wyoming.	Michigan.	Iowa.	Wisconsin.	Ohio.	Kansas.	Indiana.	Canada.	Cuba.	Mexico.
albicans.								—																
campestre.											+		+	+										
exasperatum.																								
fibrilloseum.																+						+	+	
fimbriatum.	+			+	+	+		+	+				+		+					+				
gracile.									+															
Kansense.																				+				
minutum.													+							+				
obesum.													+	+										
pedunculatum.	+	+	+	+			+	+	+	+			+	+		+	+	+		+	+			+
poculatum.						+							+	+										
punctatum.															+					+				
semisulcatum.												+								+				
subfuscum.													+											
tuberculatum.													+									+		
verrucosum.																								
Wrightii.									+															

II. CHLAMYDOPUS Speg. An. Mus. Nac. Buenos Aires, 6 : 189. pl. 4. f. 2, 3. 1899

In describing this genus Spegazzini includes two species from Argentina, *C. clavatus*, from which we cannot separate our New Mexican material, and *C. Amblaiensis* with a distinct annulus (?), and up to the present no other species of this genus have been reported. It is evident, however, from the description and figure of *Tylostoma Meyenianum* Kl.* that that species, also, belongs to the genus *Chlamydopus*. While the figure shows no trace of a volva, its tapering stem with its broad attachment to the peridium, together with its general habit would seem to indicate its relationship to

* Nov. Act. Caes. Leop. Carol. Nat. Cur. 19 : 243. pl. 5. f. 4. 1843.

this genus. The volva is of such a friable nature that it would be preserved with difficulty even if the stem had not been detached by the inattentive collector. Quite recently several specimens have been found at Mesilla Park, New Mexico, which belong here. In going over the material referred to *Tylostoma*, in the Ellis collection, two other specimens, from different localities in New Mexico, were found which though destitute of volva, evidently belong to the genus *Chlamydopus* though they may constitute another species. For the present they have been placed with *C. clavatus*.

I: CHLAMYDOPUS CLAVATUS Speg. *loc. cit.*

Peridium depressed globose, 1.5–2 cm. high, 2.2–3.5 cm. in diameter, smooth, leathery, lightish fawn-colored: mouth plane, lacerate, irregular: stem 8–15 cm. long, much enlarged at the top where it joins the peridium, 1.5–3 cm. in diameter at the top, 0.5–1.5 cm. at the base, sulcate, lacerate scaly, firm, solid, of the same color within and without as the peridium: volva friable, cup-like, with flaring sides, 1.5–2.5 cm. high, having remnants of earth and sand adhering to it: capillitium very abundant, interlaced, lightish yellow, hyaline, branched, sparingly septate, not swollen at the joints, the free ends usually rounded, 5–7 μ wide: spores subglobose, dark ferruginous, densely verrucose, 4–6 μ in diameter. (Pl. 35, f. 1–6.)

NEW MEXICO: Mesilla Park, *Cockerell*, Mesa, *Garcia*, Las Cruces, *Wooton*. Sandy soil under mesquite.

Aside from its technical characters this species presents a habit very unlike any species of *Tylostoma* found in this country. Its clean smoothish peridium and stem are quite in contrast with the usual condition found in the species of *Tylostoma*, where the rough outer peridium, and usually the stem also, is frequently covered with fragments of adhering soil. Also in the specimens of this genus, the capillitium threads are not as distinct as those of *Tylostoma* and have considerable white amorphous hyaline tissue intermingled with them.

III. BATTARREA Persoon,* Syn. Meth. Fung. 129. *pl.* 3. *f.* 1–3. 1801

It has been impossible to trace the history of *Battarrea* to its very beginning as the *Acta Anglica*, in which Woodward makes

* This genus was named for Antonio Battarra, an early Italian mycologist, and was first erroneously spelled *Batarrea* by Persoon. In 1804 the name was changed by Palisot de Beauvais to *Battarea*, but the correct spelling, *Battarrea*, was not adopted until 1825 by Fries.

first mention and gives the first drawing of this plant, has been inaccessible, but as early as 1785 Dickson* described *Lycoperdon phalloides*—"volvulatum stipilatum, pileo deflexo campanulato; supra pulverulento calyptrato, infra glabro libero"—which unquestionably was the original *Battarreia*. It was collected in September by D. Humphreys and T. Woodward at Norwich, Norfolk and Bungay, Suffolk, England. In 1801, Persoon established the genus, and named and figured one species, *B. phalloides*, which he describes as follows—"volvulata stipitata, Pileus deflexus, campanulatus, villosus, pulueris strato obsitus, a volua calyptratus." In 1814 Liboschitz† made the next mention, when he described a plant which he named *Dendromyces Stevenii*, from the river Volga, which Fries in 1839 referred to *Battarreia*. De Toni‡ gives eight species, and Fischer§ mentions seven of these, while quite lately, in 1899, Spegazzini|| described two new species from Argentina, making the number of described species ten in all.

The first *Battarreia* reported in this country was *B. phalloides*** in 1873, said to have been collected by J. Torrey in the vicinity of San Francisco, Cal., but strangely enough, though this is the well-known European species, it has never since been found, to my knowledge, in the United States. Owing to the lack of description of the plant mentioned there is a question as to whether this plant really belongs to the species indicated. The only other species so far known in this country are *B. attenuata* from Nevada, described by Professor C. H. Peck†† in 1895, and *B. Digueti*, described in the following year by M. Patouillard‡‡ from Lower California. Lastly some material has been sent to Professor L. M. Underwood from New Mexico and Arizona which proves to belong to two undescribed species.

A list of the hitherto known species with their localities is added:

* Plant. Crypt. Brit. 1: 24. 1785.

† Beschreibung eines neu entdeckten Pilzes. 1814.

‡ Saccardo, Syll. Fung. 7: 65; 9: 270; 14: 260.

§ Engler & Prantl, Die nat. Pflanzenfam. 1¹**: 344. 1900.

|| An. Mus. Nac. Buenos Aires 6: 190, 191. 1899.

** Grevillea 2: 35. 1873.

†† Bull. Torr. Club, 22: 208. 1895.

‡‡ Jour. de Bot. 10: 251. f. 2. 1886.

- B. PHALLOIDES* Pers. England, Italy, North America (?).
B. GAUDICHAUDII Mont. Peru.
B. GUICCIARDINIANA Ces. Italy.
B. TEPPERIANA Ludw. Australia.
B. STEVENII (Libosch.) Fries. Siberia.
B. DIGUETI Pat. & Har. North America.
B. ATTENUATA Peck. North America.
B. MUELLERI Kalchbr. Australia.
B. GUACHIPARUM Speg. Argentina.
B. PATAGONICA Speg. Argentina.

Synopsis of the North American Species

Stem hollow.

Plants more than 20 cm. high; volva double, the inner layers split into numerous leaves. 1. *B. laciniata*.

Plants 20 cm. high or less.

Spores minutely verrucose; volva simple. 2. *B. Griffithsii*.

Spores nearly smooth; volva triple. 3. *B. Digueti*.

Stem solid.

4. *B. attenuata*.

1. *Battarrea laciniata* Underwood, sp. nov.

Peridium 5-6 cm. in diameter, 2-3 cm. high, smooth, membranaceous, the upper portion sometimes having portions of the outer coat of the volva adhering to it: the lower portion after the spores have been shed is a yellowish-white and shows traces of where the capillitium has sprung: stem 25-35 cm. long, woody, hollow, stuffed with silky, thread-like fibers running about half way down the center of the stem, outer coat fibrous, peeling, sometimes merely lacerate, at others shaggy, slightly tapering to the base, about 2.5 cm. at the top and 1.5 cm. at the base: volva complex, composed of a thick outer coating, and an inner set of very numerous thin leaflets arranged more or less in layers about the stem: capillitium whitish, hyaline, indefinite, irregular, somewhat fascicular: cells 30-50 μ long, 5-7 μ wide, with raised annular thickenings or nearly flat spiral markings: spores subglobose, reddish-brown, 5-7 μ in diameter, almost smooth. (Pl. 36, f. 1-6.)

NEW MEXICO: Mesilla Park, *Cockerell*.

This plant resembles *B. Digueti* in some of its characters, but it is distinguishable (1) By its much larger size, (2) By its having no inner woody volva enclosing the lower portion of the stem, (3) In the much larger number of leaflets which compose the inner portion of the volva, and (4) In the different coloring and marking

of the cells. The plants vary considerably as to size and roughness of the stem.

2. **Battarrea Griffithsii** Underwood, sp. nov.

Peridium 2–3.5 cm. in diameter, 1–2 cm. high, smooth, membranaceous, lower part flat, showing the line of dehiscence distinctly: stem hollow, equal, 1–1.5 cm. in diameter, 9.5–15 cm. long, sulcate, peeling fibrillose: volva fairly well marked, composed of a few appressed fibrillose blunt squamules: capillitium 4–10 μ wide, whitish, flattened, rather amorphous, branched, and having a large number of cells mixed with it: cells darker than the capillitium, with spiral markings and annular thickenings, 6–8 μ wide, 24–85 μ long: spores subglobose, minutely verrucose, looking smooth except under very high magnification, reddish-cinnamon colored, 4–5 μ in diameter. (Pl. 37, f. 1–6.)

ARIZONA, *David Griffiths*, to whom the species is dedicated.

3. **BATTARREA DIGUETI** Pat. & Har. Jour. de Bot. **10**: 251. *pl.*
2. *f.* 1–6. 1896

Peridium depressed globose, membranaceous: stem 15–20 cm. long, 8–10 mm. wide: spores globose, ferruginous, 5–6 μ in diameter: cells 100–150 μ long, 4–7 μ wide, with darker yellow annular markings: volva of three layers, the outer one woody, simple, whitish, the inner woody and simple, and encircling the lower third part of the stem, the third layer between the outer and inner volva is composed of from 10 to 20 thin membranaceous leaflets.

LOWER CALIFORNIA, *Diguet*. In barren rocky soil.

No specimens of this species have been seen, but it has been thought best to quote the above partial translation of M. Patouillard's very full description.

4. **BATTARREA ATTENUATA** Peck, Bull. Torr. Club, **22**: 208. 1895

"Exoperidium unknown: endoperidium 2 in. or more in breadth, the basal part hard, thick, even and concave beneath, convex above, and somewhat coarsely reticulated by the bounding walls of broad shallow pits: stem 8 to 10 in. long, gradually attenuated toward the base, hard, almost woody, solid, rough except at the top, with rather coarse spreading or reflexed scales, brown externally, rusty brown within: spores globose, ferruginous, .0003 in. broad: threads of the capillitium destitute of spiral thickenings.

"Plant commonly growing in tufts of 3–5 individuals. Dry sandy soil. Nevada. Collected by C. W. Irish; communicated by Dr. Thomas Taylor."

The single specimen of this species known is at Albany and is inaccessible at the present time, so the above original description has been quoted verbatim.

IV. QUELETIA Fries. Öfversigt Kongl. Vetens. Akad. Förhandlingar, Stockholm, 171. *pl.* 4. 1871

This genus was established on a single species, and as yet no others are known. It is very rare, having been reported from very few localities. It was discovered by Dr. L. Quelet, at Herimncourt, France, and has since been reported from the environs of Rouen (Saint-Saens), and Pont de Sochaux, France. It has been found only once in the United States, at Trexlertown, Penn., by Mr. William Herbst, and was reported by Professor C. H. Peck, in his 46th report of the State Botanist. He is of the opinion that this plant was introduced into this country in some way with tan bark, on which it usually grows.

I. QUELETIA MIRABILIS Fries, *loc. cit.*

Peridium globose, 2.5–3.5 cm. high, 3–4 cm. in diameter, fragile, easily separating from the stem, rupturing irregularly, of a reddish-brown color: collar irregular, of the same substance as the peridium: stem 6.5–8 cm. long, 1.5 cm. wide at the top, 2 cm. at the base, fascicular, reddish-brown, within and without, like the peridium, solid, lacerate, fibrillose, particularly at the base: capillitium very abundant and interwoven, forming with the spores a felt-like mass, reddish-brown, single threads whitish-yellow, thick-walled, hollow as shown by the truncated ends, septa rare or wanting, 5–9 μ wide, branches rather short, free ends rounded and recurved: spores subglobose, coarsely warted, 4–6 μ in diameter, some short-pediceled, inner portion breaking up and issuing from the thin-warted coating which is then hyaline and shrivelled. (Pl. 38, f. 1–5.)

PENNSYLVANIA: Trexlertown, *Herbst*. On spent tan bark. Summer, after rains, forming circles.

V. DICTYOCEPHALOS Underwood, gen. nov.

Plants with the irregularly rupturing peridium closely attached to the solid stem. Volva cup-like, persistent at the base of the stem. Gleba composed of a mesh-like irregular tissue, in which the capillitium threads are embedded.

1. *Dictyocephalos curvatus* Underwood, sp. nov.

Outer peridium of a thick woody texture, bearing a definite cup-like volva at the base of the stem, the upper portion being carried up on the peridium, and either falling off or remaining adherent to it: inner peridium scleroderma-like, rough, dark brown, scaly, rather flattened sideways, rupturing irregularly, 3-6 cm. high, 5-8 cm. in diameter: stem 25-40 cm. long, 3-6 cm. in diameter at the summit, 1.5-4 cm. in diameter at the base, considerably flattened, twisted, solid, dark brown within and without, sulcate, the outer surface very uneven, and peeling: the collar indistinct, formed by the lower portion of the peridium adhering to the top of the stem and becoming torn as the stem elongates: the top of the stem is rounded and projects into the peridium forming a pseudo-columella, of a yellowish-brown color, lighter than the rest of plant, marked with irregular, reticulated pits, from the sides of which the mesh-like tissue springs which forms with the spore mass the main part of the gleba: capillitium 8-10 μ wide, mostly embedded in the mesh-like tissue, bright yellow, cylindric, septate, not much swollen at the joints, branched, the free ends rounded: spores subglobose, warty, 5-7 μ in diameter. (Pl. 39, 40.)

COLORADO: Colorow, *Bethel*.

Plants with a strong odor which in the dry condition much resembles that of the dried bark of *Ulmus fulva*. The spores of these specimens first appeared to be of two kinds—darker warted, larger ones, and smaller, smooth, light colored ones—but it was soon seen that this was owing to the outer coat having been eaten off by the quantities of small insects by which these plants were infested.

These strange plants were found by Mr. E. Bethel at Colorow, Col., in the month of August, 1897. In the notes sent with these specimens to Mr. Ellis, Mr. Bethel says: "These plants are very odd-looking in their native haunts; they grow on a soft alkaline adobe soil. Some of them had lifted themselves entirely out of the ground, while others had the stalk standing in about one inch of soil. They presented a very fantastic appearance, as there was little or no other vegetation about. * * * Some of the specimens were very much bent, approximating a semicircle, others were twisted like a corkscrew, with the portions of the stalk split and bent back. I think the chief factor in lifting the plant out of the ground is this twisting and bending back of the portions of the stem during dessication."

Explanation of Plates

In most cases the drawings have been made twice natural size and reduced one half. The capillitium and spores were drawn with a camera lucida under double the magnification noted.

PLATE 31

- FIG. 1. *Tylostoma pedunculatum*, nat. size.
FIG. 2. Spores and capillitium, $\times 170$.
FIG. 3. Spores, $\times 310$.
FIG. 4, 5. *Tylostoma albicans*, nat. size.
FIG. 6. Spores and capillitium, $\times 170$.
FIG. 7. Spores, $\times 310$.
FIG. 8. *Tylostoma verrucosum*, nat. size.
FIG. 9. Spores and capillitium, $\times 170$.
FIG. 10. Spores, $\times 310$.
FIG. 11. *Tylostoma minutum*, nat. size.
FIG. 12. Spores and capillitium, $\times 170$.
FIG. 13. Spores, $\times 310$.

PLATE 32

- FIG. 1. *Tylostoma gracile*, nat. size.
FIG. 2. Spores and capillitium, $\times 170$.
FIG. 3. Spores, $\times 310$.
FIG. 4. *Tylostoma obesum*, nat. size.
FIG. 5. Spores and capillitium, $\times 170$.
FIG. 6. Spores, $\times 310$.
FIG. 7. *Tylostoma Kansense*, nat. size.
FIG. 8. Spores and capillitium, $\times 170$.
FIG. 9. Spores, $\times 310$.

PLATE 33

- FIG. 1. *Tylostoma exasperatum*, nat. size.
FIG. 2. Spores and capillitium, $\times 170$.
FIG. 3. Spores, $\times 310$.
FIG. 4. *Tylostoma fibrillosum*, nat. size.
FIG. 5. Spores and capillitium, $\times 170$.
FIG. 6. Spores, $\times 310$.
FIG. 7. *Tylostoma tuberculatum*, nat. size.
FIG. 8. Spores and capillitium, $\times 170$.
FIG. 9. Spores, $\times 310$.
FIG. 10. *Tylostoma campestre*, nat. size.
FIG. 11. Spores and capillitium, $\times 170$.
FIG. 12. Spores, $\times 310$.

PLATE 34

- FIG. 1. *Tylostoma punctatum*, nat. size.
FIG. 2. Spores and capillitium, $\times 170$.
FIG. 3. Spores, $\times 310$.
FIG. 4. *Tylostoma poculatum*, nat. size.
FIG. 5. Spores and capillitium, $\times 170$.
FIG. 6. Spores, $\times 310$.

FIG. 7. *Tylostoma fimbriatum*, nat. size.

FIG. 8. Spores and capillitium, $\times 170$.

FIG. 9. Spores, $\times 310$.

FIG. 10. *Tylostoma subfuscum*, nat. size.

FIG. 11. Spores and capillitium, $\times 170$.

FIG. 12. Spores, $\times 310$.

PLATE 35

FIG. 1. *Chlamydopus clavatus*, nat. size.

FIG. 2. Spores and capillitium, $\times 170$.

FIG. 3. Spores, $\times 310$.

FIG. 4. Single spores, $\times 450$.

FIG. 5. Peridium showing lacerate mouth, and enlarged stem, nat. size.

FIG. 6. Section through peridium and stem.

PLATE 36

FIG. 1. *Battarrea laciniata*, $\frac{1}{2}$ nat. size.

FIG. 2. Spores and capillitium, $\times 170$.

FIG. 3. Spores, $\times 310$.

FIG. 4. Cells, $\times 310$.

FIG. 5. Cell after desiccation, $\times 310$.

FIG. 6. Peridium, nat. size, showing attachment to the stem.

PLATE 37

FIG. 1. *Battarrea Griffithsii*, nat. size.

FIG. 2. Specimen showing under side of peridium, volva missing, nat. size.

FIG. 3. Peridium showing method of dehiscence, nat. size.

FIG. 4. Spores, capillitium and cells, $\times 170$.

FIG. 5. Spores, $\times 310$.

FIG. 6. Cells, $\times 310$.

PLATE 38

FIG. 1. *Queletia mirabilis*, nat. size.

FIG. 2. Spores and capillitium, $\times 170$.

FIG. 3. Spores, $\times 310$.

FIG. 4. Spores, showing breaking up of inner substance, $\times 310$.

FIG. 5. Section through the peridium, showing detachment of stem, nat. size.

PLATE 39

FIG. 1. *Dictyocephalos curvatus*, $\frac{1}{2}$ nat. size.

FIG. 2. Lower portion of stem, and double volva, $\frac{1}{2}$ nat. size.

FIG. 3. Peridium, ruptured irregularly, with remnants of mesh-like tissue, $\frac{1}{2}$ nat. size.

FIG. 4. Portion of tissue with spores and capillitium embedded in it, $\times 170$.

PLATE 40

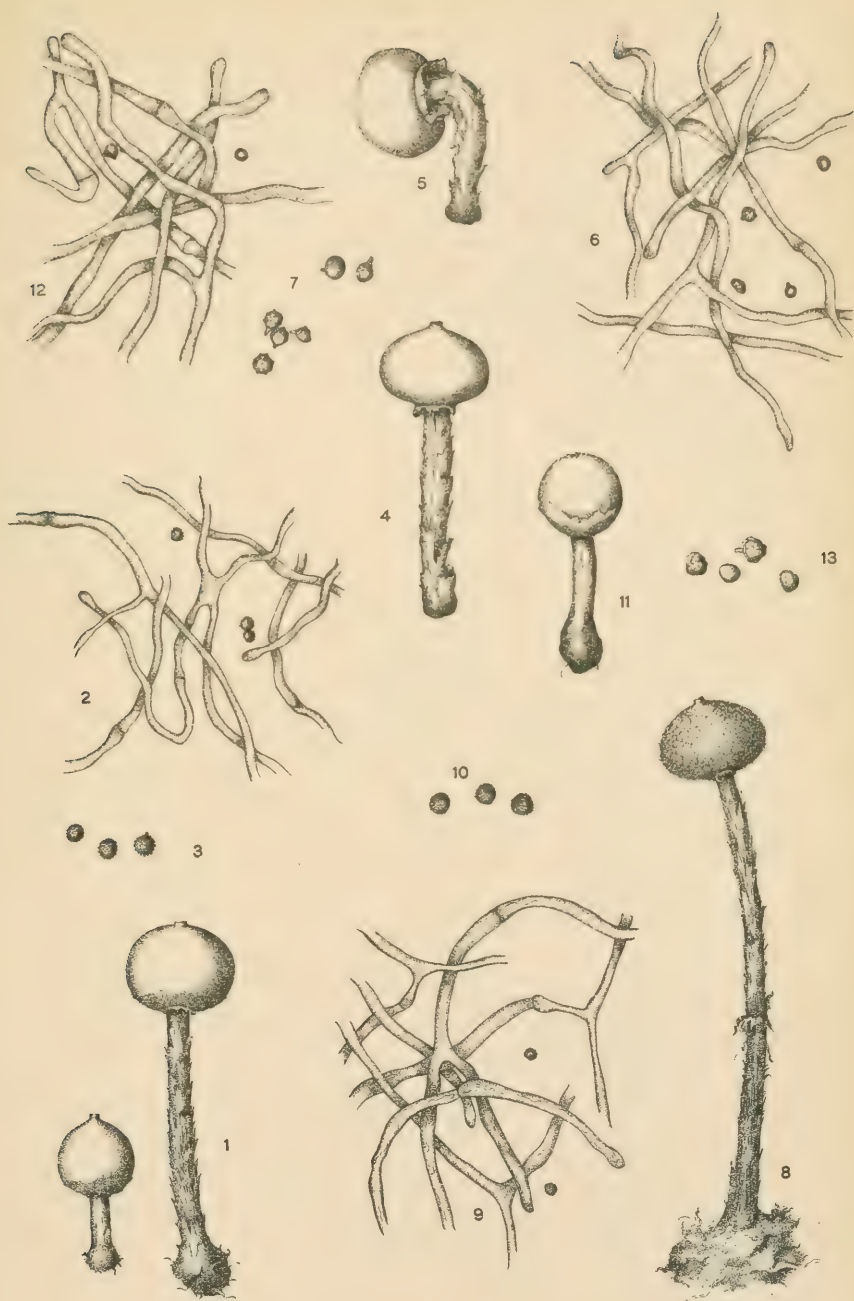
FIG. 5. *Dictyocephalos curvatus*, $\frac{3}{4}$ nat. size.

FIG. 6. Spore, $\times 465$.

FIG. 7. Inner portion of spore issuing from outer coat, $\times 465$.

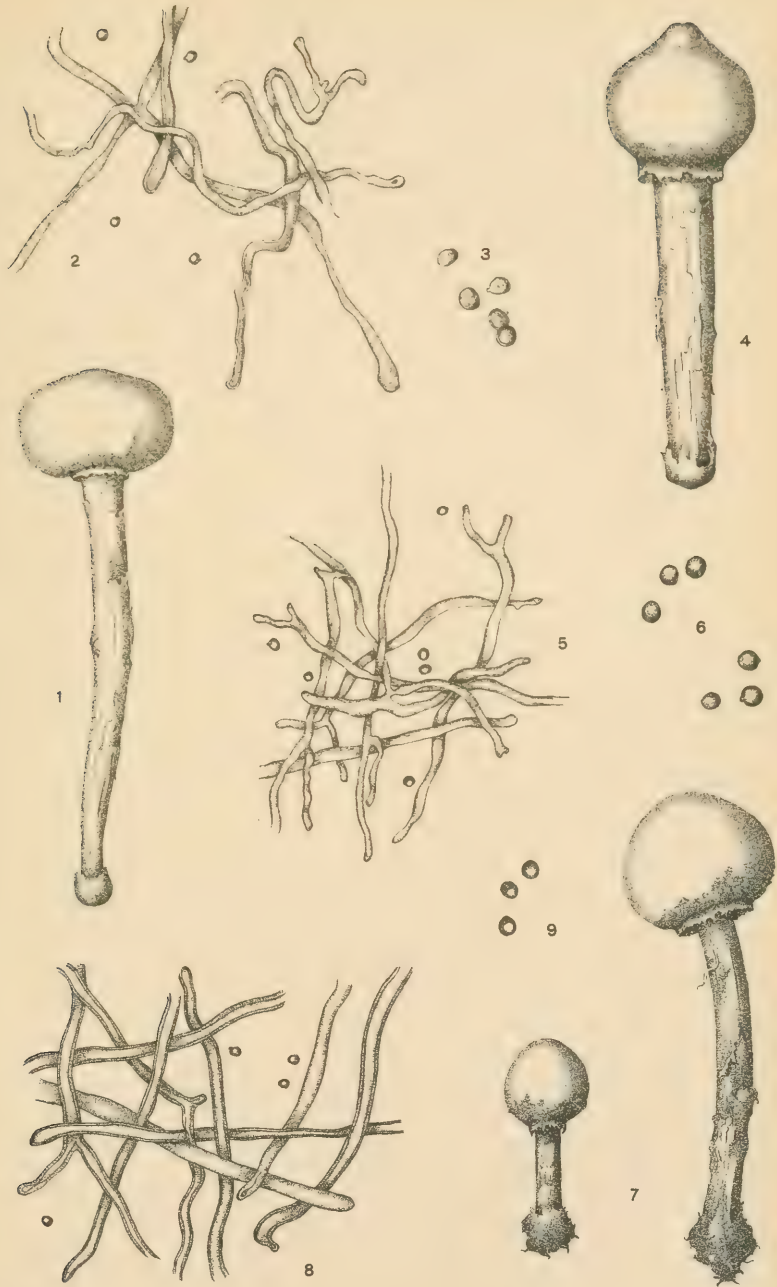
FIG. 8. Empty, hyaline spore coats, $\times 465$.

FIG. 9. Smooth inner spores after issuing from outer coat, $\times 465$.



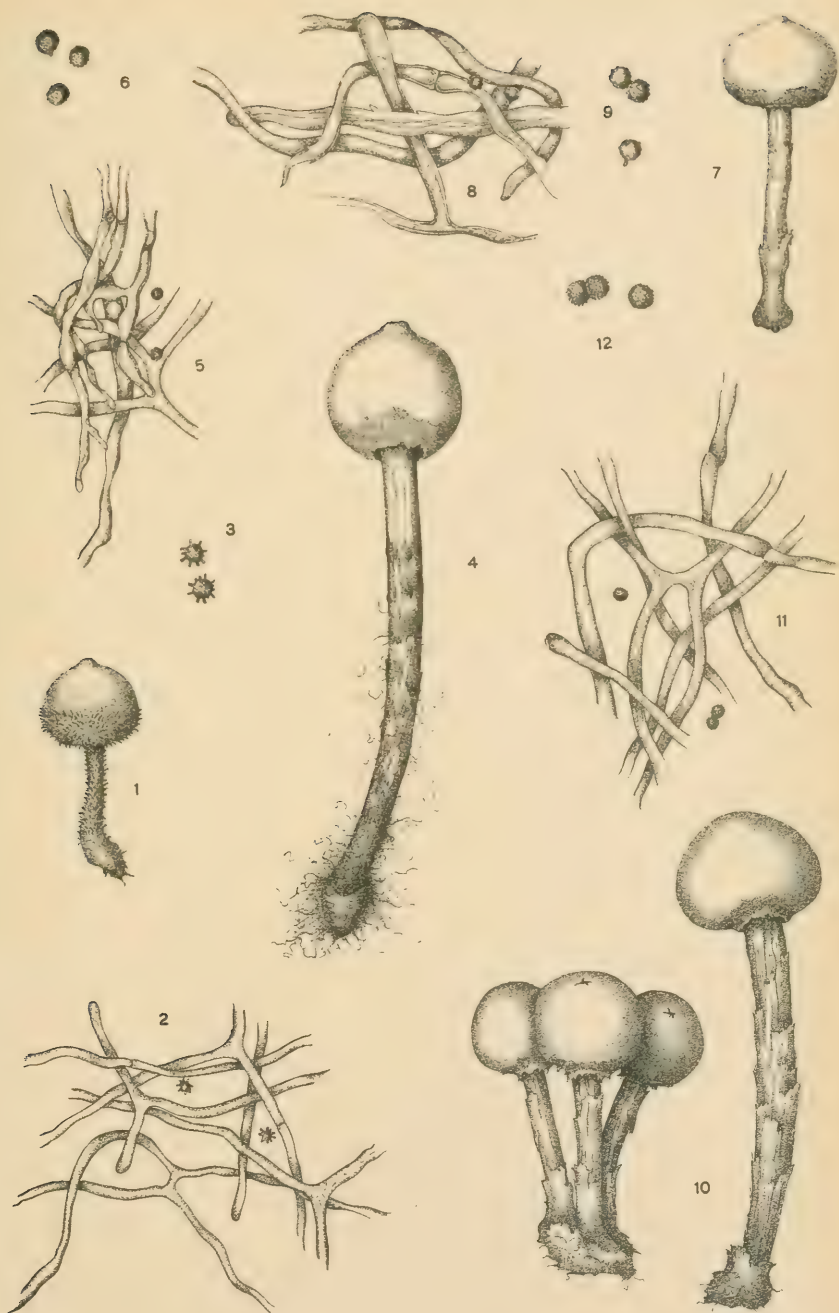
V. S. W. Del.

TYLOSTOMA



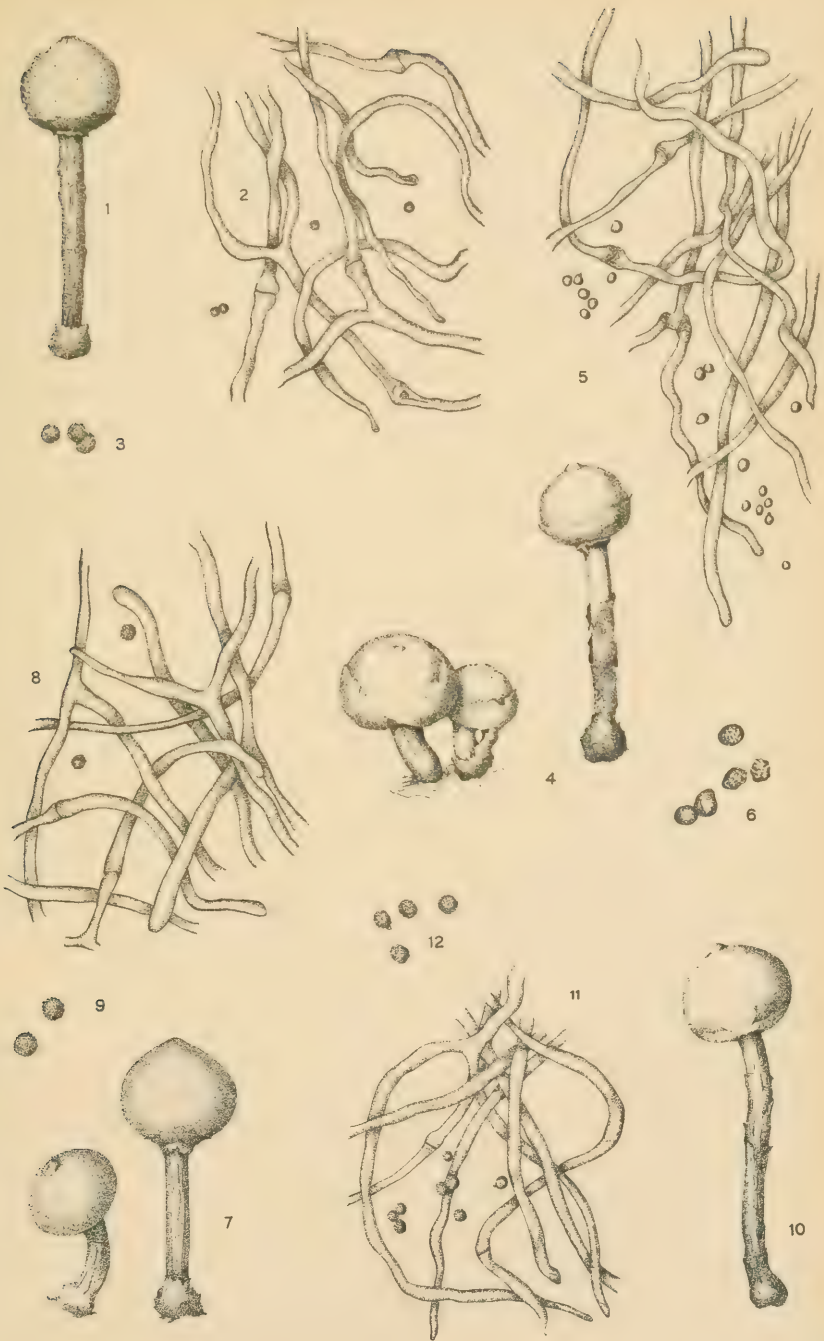
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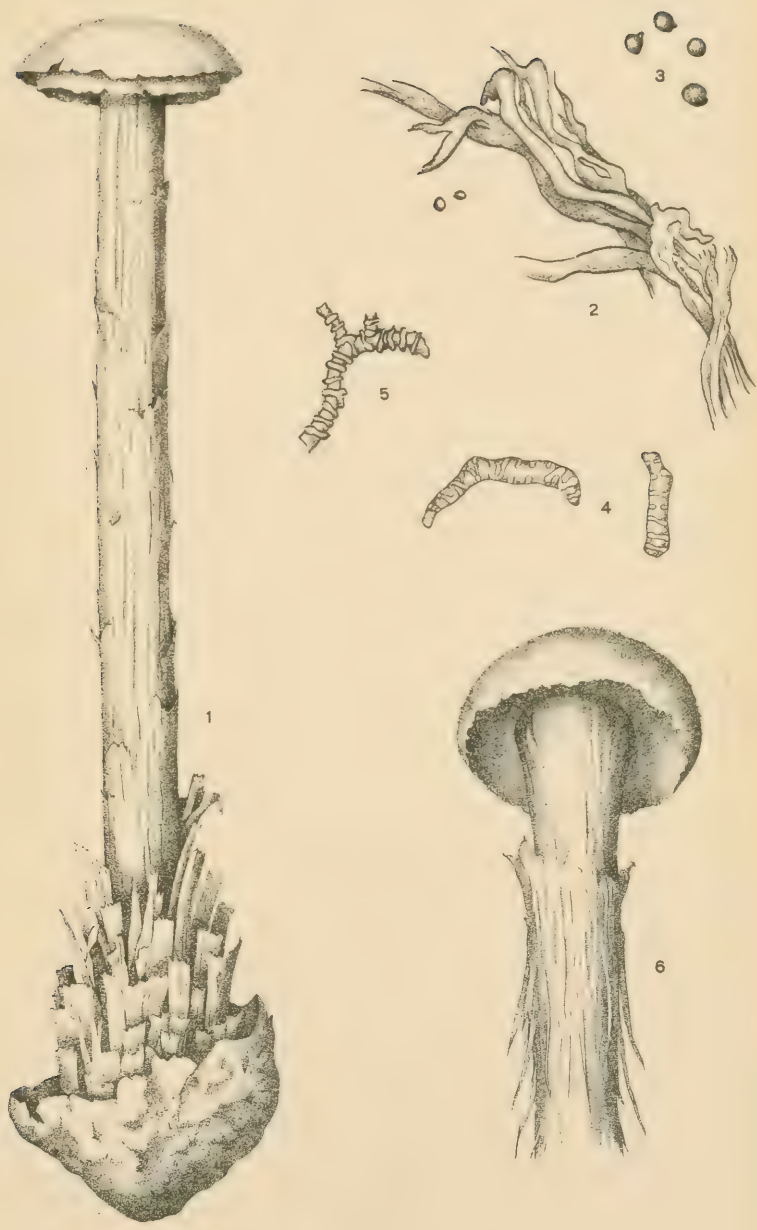
V. S. W. Del.

TYLOSTOMA



CHLAMYDOPUS

V. S. W. Del.



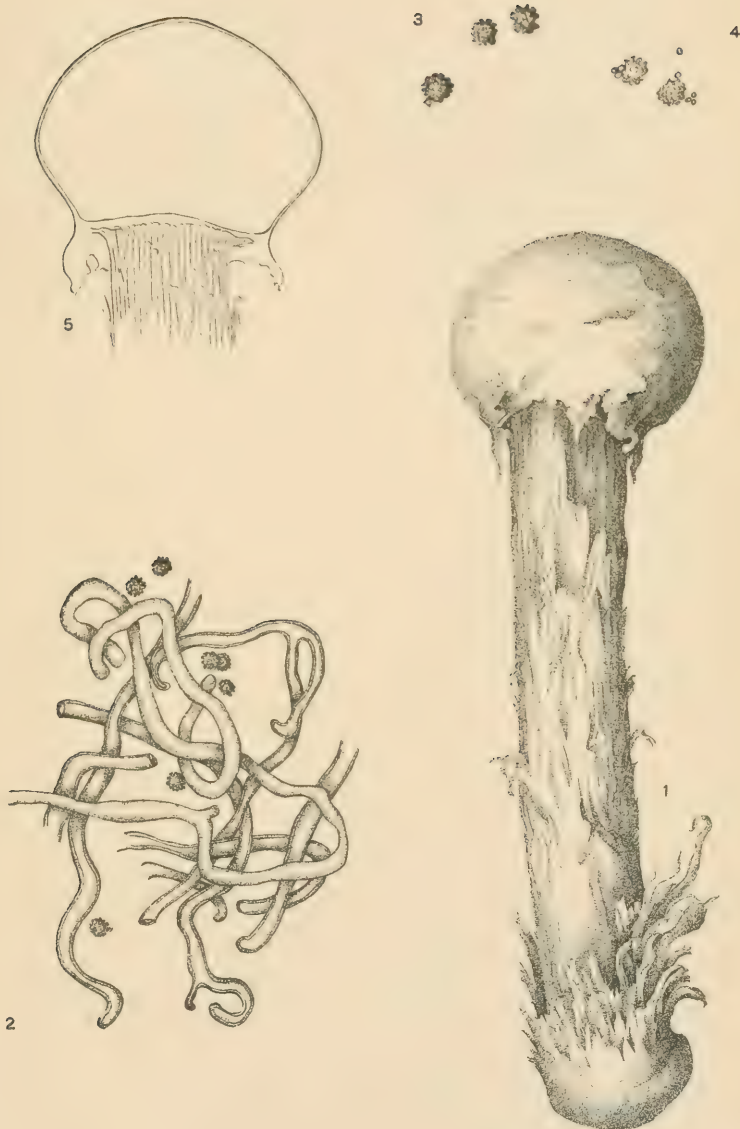
V. S. W. Del.

BATTARREA



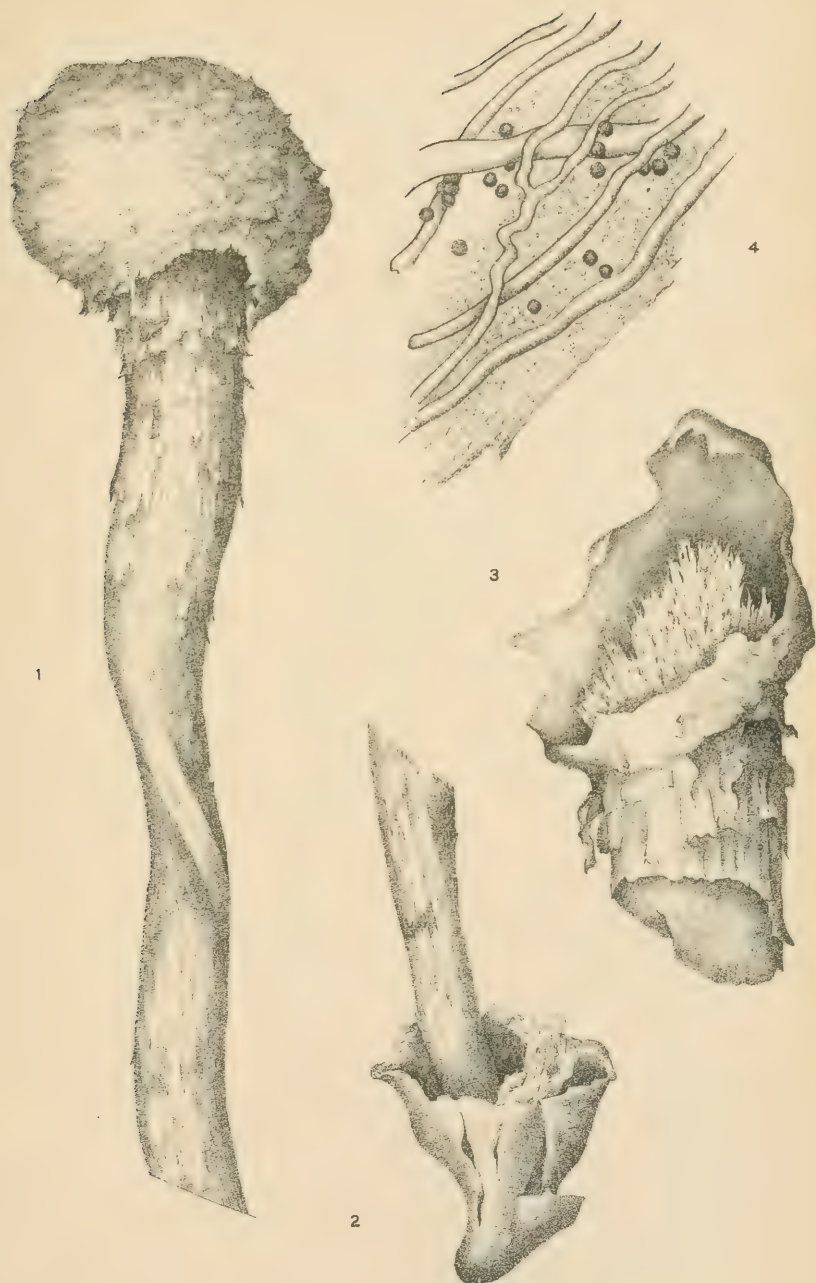
BATTARREA

V. S. W. Del



QUELETIA

V. S. W. Del.



V. S. W. Del.

DICTYOCEPHALOS



DICTYOCEPHALOS

V. S. W. Del.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 18

SHRUBS AND TREES
OF THE
SOUTHERN STATES.
I, II, III, IV.

BY JOHN K. SMALL

NEW YORK
1901

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB.]

Shrubs and Trees of the Southern States.—I.

BY JOHN K. SMALL.

TSUGA CAROLINIANA Engelm. Coult. Bot. Gaz. 6: 223. 1881.

I have already reported this rare hemlock from Georgia* and can now record a second station, at Tallulah Falls, several miles below the first one. At the second station the trees grow in a more accessible position and reach a better development, there being plenty of soil. The station is towards the lower end of the cañon, on the south side, where the bank slopes at an angle of 45° or more, and about 1000 feet above the river. Owing to a drenching rain which prevailed during my stay at Tallulah I could not ascertain the extent of this grove.

PINUS PUNGENS Michx. f. Hist. Arb. Am. 1: 61. *pl.* 5. 1810.

I can now report this most locally distributed of our mountain-inhabiting pines for the flora of Georgia, having encountered it in the lower part of the cañon at Tallulah Falls. For the same reason given in the foregoing paragraph, I am unable to tell the size of the grove, but it is extensive and the trees are larger than I have seen them elsewhere in the southern mountains.

SALIX WARDII Bebb, Gard. & For. 8: 363. 1895.

At the Falls of the Yadkin river in North Carolina both *Salix nigra* and *Salix Wardii* are plentiful, the black willow growing along the water's edge on the south side of the river, while *Salix*

* Bull. Torr. Club, 22: 45.

Wardii occurs on the opposite shore hardly two hundred yards distant, the two species being respectively confined to the north and south sides of the river. The form of *Salix Wardii* occurring there is peculiar; the bushes are smaller than any heretofore observed, diffusely branched and the branches decumbent or almost prostrate, spreading radially and forming large, tangled mats, seldom rising more than six inches above the ground.

QUERCUS NANA (Marsh.) Sarg. Gard. & Forest, 8: 93. 1895.

I was much surprised to find quantities of this scrub oak on the summit of King's and Crowder's Mountains near the southern boundary of North Carolina in the summer of 1894. The locality is within several miles of South Carolina and about one hundred miles east of the Blue Ridge.

QUERCUS RUBRA L. Sp. Pl. 996. 1753.

The existence of the red oak in Georgia was unknown to botanists before 1893. In that year I discovered a few trees just south of the North Carolina boundary, on the summit of the Thomas Bald, at an altitude of 5200 feet. The trees were stunted and irregular, as is characteristic at high altitudes. Last year, however, I found a remarkable development of the species in the northwestern corner of Georgia, in Catoosa county. The species abounds in the limestone "bottoms;" trees three feet or more in diameter are not uncommon, their trunks, naked often for seventy-five feet from the ground, are so straight that it is impossible to tell which way they will fall when cut off at the base. The thick bark is more or less mottled, whence the local name "Leopard Oak."

CELTIS MISSISSIPPIENSIS Bosc. Encycl. Agric. 7: 577. 1822.

Although extending over most of the western part of Georgia, this species of hackberry reaches its greatest development in the rich limestone "bottoms" in the region east of Lookout Mountain. Gigantic trunks, three or four feet in diameter, are very common, and are covered with innumerable corky warts, which range from one to two or even three inches in height.

DARBYA UMBELLULATA A. Gray, Am. Journ. Sci. (II.) 1: 388. 1846.

I have lately discovered a new station for this rare plant. It

grows in limited quantities on the south banks of the Yellow River, near McGuire's Mill, Gwinnett county, Georgia. I found it in company with its near relative, *Comandra umbellata*.

MAGNOLIA TRIPETALA L. Sp. Pl. Ed. 2, 756. 1763.

Another species new to the flora of Georgia, apparently never found so far southeast of the Blue Ridge. I first encountered some trees at the northern base of Stone Mountain, and later at several localities near the mountain. The trees are small and slender, and the species does not thrive as it does farther north.

CRATAEGUS ELLIPTICA Ait. Hort. Kew. 2: 168. 1787.

On several occasions, while collecting between Tallulah Falls and Toccoa Falls and in the Nacoochee Valley in northern Georgia I have observed numerous groves of *Crataegus elliptica* growing on the barren slopes of low hills, usually above streams, at altitudes varying from 1000-1500 feet. After several seasons' study of this form in the field I can see no reason for uniting it with *Crataegus flava* as a variety, as has lately been done.* Besides characters in the habit, the leaves, the fruit and seeds, which serve to separate it specifically from *Crataegus flava*, I find an apparent trustworthy distinction in the bark of the trunk. The bark of *Crataegus flava* is black and in high narrow ridges, while that of *Crataegus elliptica* is a light brown and in thin broad scales.

CRATAEGUS ROTUNDIFOLIA (Ehrh.) Borck. in Roem. Arch 1: Pt. 3, 87. 1798.

This species of *Crataegus* is very common in the southern Alleghanies and extends southward almost to the Gulf of Mexico. In 1895 I found it throughout the southern part of Georgia, where its favorite situation is the low ridges in the pine barrens, where the different species of hardwoods abound.

CLIFTONIA MONOPHYLLA (Lam.) Britton, Bull. Torr. Club, 16: 310. 1889.

This curious and local plant forms remarkably dense thickets in the swamps and districts bordering streams in the vicinity of the Altamaha river, especially north of Jesup, Georgia. The

* Silva of N. A. 4: 114.

stems there range from one-half of an inch to one foot in diameter, and the thickets they form remind one of those made by the growth of *Kalmia latifolia* and *Rhododendron maximum* on the higher mountains of North Carolina.

ACER LEUCODERME Small, Bull. Torr. Club, 22: 367. 1895.

When first described this species was thought to be confined to the middle country of the Southern States, but my extensive journeys in Georgia last season brought to light two new stations in the foothills of the Blue Ridge and the Alleghanies; one is the deep cañon just below the precipice of Toccoa Falls, the other a shallow cañon along the Little Chickamauga creek near Ringgold. Both stations are similar to the original, and at both the tree holds all its characters.

ACER FLORIDANUM (Chapm.) Pax, Engler's Bot. Jahrb. 7: 243, 1886.

This characteristic maple is apparently very common in the river swamps of the Flint River in southwestern Georgia. Last summer I encountered a remarkable growth just below Albany. It probably follows the river to its mouth, for I again met it in the vicinity of Bainbridge. The trees are conspicuous on account of their close white bark and very dark foliage. Although said to be a small tree I measured many trunks that were three feet in diameter.

VACCINIUM HIRSUTUM Buckl. Am. Journ. Sci. 45: 175. 1844.

In April, 1893, I discovered this local and little-known huckleberry on the southern cliffs of the cañon at Tallulah Falls, Georgia. This apparently is the first collection since the original discovery by Buckley in Cherokee County, North Carolina. In 1894 Prof. A. Ruth found the shrub on the Cade's Cove Mountains in eastern Tennessee, thus adding the third station and the third State in which the species is known to exist.

Shrubs and Trees of the Southern States.—II.

BY JOHN K. SMALL.

I. NEW AND NOTEWORTHY SPECIES.

TSUGA CAROLINIANA Engelm. Coult. Bot. Gaz. 6: 223. 1881.

Last fall I received specimens of this very ornamental hemlock from two new localities in North Carolina. Mr. A. M. Huger found groves of it at Banner's Elk, Watauga County, at an elevation of 1300 meters and in the Linville Gorge, Burke County, at about 575 meters above sea-level, the latter station, together with that at Tallulah Falls, Georgia, and the New River, Virginia, representing the lowest altitudes at which the species has been found.

HICORIA GLABRA (Mill.) Britton, Bull. Torr. Club, 15: 284. 1888.

Among the many unique things that Stone Mountain affords are some dwarf hickory trees, usually less than two meters in height, bearing quite an abundance of fruit.

QUERCUS MINIMA (Sarg.)

Quercus virens var. *dentata* Chapm. Fl. S. States, 421. 1860.
Not *Q. dentata* Bartr. 1794.

Quercus Virginiana var. *minima* Sarg. Silva N. A. : 101. 1895.

A low shrub forming wide patches by the extensive spreading of the underground stems. Branches erect or ascending, less than 1 meter tall, solitary or several together, simple, or branched above; leaves firm, obovate or sometimes oblong to oblanceolate, 3-10 cm. long, acute or apiculate at the apex, repand-serrate, or the upper ones sometimes entire, those of the shoots often lobed, all glabrous or finely tomentose beneath, gradually or abruptly narrowed into short petioles which vary from 2-5 mm. in length; staminate aments very slender, 1-4 cm. long, tomentose; acorns solitary or several at the ends of peduncles which vary from 1-3 cm. in length, or sometimes sessile; cups turbinate hemispheric, about 1.5 cm. broad, white-tomentose, the bracts appressed, thickened on the back, except near its edge where they form a fringe; nuts ovoid or elliptic, 1.5-1.8 cm. long, dark brown, glabrous.

Sandy sterile pine barrens, Florida, chiefly near the coast. Flowers in March and April; matures its fruit in the fall.

This peculiar oak cannot pose as a variety of *Quercus Virginiana* under any reasonable considerations. It may be of interest to note that it bears much the same relation to *Quercus Virginiana* as *Castanea nana* does to *Castanea pumila* or *Castanea dentata*. The habit of *Quercus minima*, with its underground stems, and low erect branches which are usually much less than one meter in height, is enough to separate it specifically from the gigantic forest tree *Quercus Virginiana*. In addition to the differences in habit just mentioned, the leaf types are characteristic and the nerves in the leaves of *Quercus minima* are much more prominent than they are in the live oak. The cups seem to furnish a diagnostic character, those of the *Quercus minima* being of a turbinate type, while those of *Quercus Virginiana* are hemispheric.

QUERCUS GEMINATA n. sp.

A shrub or small tree, 2-5 meters tall, with a maximum trunk diameter of about 15 cm. Leaves narrowly oblong, elliptic, or oblong-oblanceolate, 3-6 cm. long, entire, obtuse or apiculate, strongly revolute, mostly gradually narrowed at the base, glabrous and parchment-like above, finely tomentose and conspicuously rugose by the prominent nerves beneath; petioles 2-6 mm.

long; flowers not seen; acorns usually 2 at the end of a peduncle, which varies from 1-4 cm. in length; cups turbinate, 1 cm. broad, tomentose, the bracts appressed, slightly thickened near the base of the cup, fringed at the edge; nuts ovoid or narrowly oval, 1-1.7 cm. long, twice or thrice as long as the cups.

Sandy soil, chiefly in the scrub, Florida. Flowers in spring and matures its fruit in the fall.

Mr. Nash, who collected and observed this plant during the seasons of 1894 and 1895, assures me that it is perfectly distinct from its relatives. This is doubtless a fact, and both the foliage and fruit furnish excellent characters. The very prominently rugose lower leaf-surfaces and the strongly revolute leaf-margins have no parallel in *Quercus Virginiana*. The acorns are always borne in pairs at the ends of short stout peduncles; the turbinate cups with their constricted bases are diagnostic.

CELTIS GEORGIANA n. sp.

A diffuse shrub with slender often 2-ranked branches, the leafy twigs more or less pubescent. Leaves ovate, 2-5 cm. long, averaging 2.5 cm. in length, or those on vigorous shoots sometimes 6 cm. long, acute, entire or sharply serrate above the middle, inequilateral, rounded or truncate at the oblique base, dark green, scabrous and occasionally sparingly pubescent above, paler and glabrous beneath, except for a few hairs on the nerves; petioles 1.5-4 mm. long, pubescent; pedicels usually slightly curved, 1.5-4 mm. long, pubescent; drupes subglobose, sometimes broader than long, 6-7 mm. in diameter, tan-color, smooth and glabrous, or sometimes glaucous; seeds obovoid-globose.

Along or near streams, north-central Georgia. Flowers in the spring; matures its fruit in September.

Collected by the writer, first in the Yellow River Valley, near McGuire's Mill, Gwinnette County, in 1893, and in succeeding years at many points about Stone Mountain and the contiguous region.

A low species related to *Celtis pumila*, from which it may be distinguished by its smaller merely acute leaves, the very short pedicels and the smaller tan-colored drupes.

CELTIS HELLERI n. sp.

A much branched, wide spreading tree, sometimes 10 meters tall with a maximum trunk diameter of 1.5 meters. Bark of the

trunk and main branches with numerous corky warts; leaves rather firm, the blades ovate to oblong, 4-7 cm. long, obtuse or acute, crenate-serrate, especially above the middle, rounded or subcordate at the base, deep-green and scabrous-pubescent above, pale and tomentose beneath, slightly inequilateral, oblique at the base; petioles stout, 3-4 mm. long, tomentose; pedicels sparingly pubescent, curved, 1-1.5 cm. long; drupe subglobose, 7-9 mm. in diameter, light-brown, translucent, smooth and shining; seeds globose, strongly 4-ribbed, prominently reticulated.

In dry ground near San Antonio, Texas.

A rather low tree with a short stout trunk varying from .5-1.5 meters in diameter, and a wide spreading top. The branches are numerous and bulky. The original specimens were gathered by Mr. Heller from trees growing in a strip of woodland between the city of San Antonio and the San Antonio River, Texas, no. 1587.

TOXYLON POMIFERUM Raf. Am. Month. Mag. 2: 118. 1817.

Years ago the osage orange was planted on Paris Mountain, South Carolina, for hedges and for ornamental purposes. For many years the settlements have been neglected and deserted and the tree has spread and established itself in an astonishing manner, now appearing as if indigenous.

ALBIZZIA JULIBRISSIN Durazz. Mag. Tosc. 3: 11. 1772.

Although not indigenous, this tree now appears as if it were native in the southern states. It grows along roadsides and here and there through the pine woods much as the honey locust (*Gleditsia triacanthos*) does in many localities. It ranges from North Carolina to Georgia, Florida and Alabama, where Prof. Underwood collected specimens during the past summer. It is quite abundant in southern Georgia.

AMORPHIA VIRGATA Small, Bull. Torr. Club, 21: 17. *pl.* 171. 1894.

In the spring of 1896 Dr. Charles Mohr sent me a specimen of *Amorpha virgata* from the mountains of Madison county, Alabama, thus extending the known geographic range of the species from Stone Mountain, Georgia, to northern Alabama. Dr. Mohr gives the altitude of this locality as 350 meters. While collecting at different points along the eastern section of the Blue Ridge dur-

ing the summer of 1896, I was surprised to find the species both on the slopes and summit of Paris Mountain near Greenville, and on the slopes of Table Mountain. At the former locality it occurred at an altitude of about 500 metres, and on Table Mountain it ranged from 800-900 meters. Its characters hold perfectly.

LONICERA FLAVA Sims. Bot. Mag., *pl.* 1318. 1810.

About two years ago I recorded* several new localities for this handsome honeysuckle. Further exploration of the southern end of the Blue Ridge has revealed additional stations. In the summer of 1894 I found some bushes on the upper slopes of Currahee Mountain, an isolated peak near Toccoa, Georgia, and a little later noticed several bushes on Stone Mountain. During the past summer I collected it on Paris Mountain, South Carolina, the original locality, where it grows at several points along the rocky summit, and later discovered a new station on the precipitous cliffs of Table Mountain, in the same state. At the latter place the shrubs were more robust and vigorous than at any of the other stations.

The finest flowering specimens I have ever seen were sent me by Mr. A. M. Huger, who secured them on Tyron Mountain, Polk County, North Carolina, last spring. Mr. Huger's discovery extends the range of the species into another state, but although we now have specimens showing the species to range from North Carolina to Georgia, it is not common at any of the localities, a few bushes only existing at the different places.

II. THE GENUS GAYLUSSACIA IN THE SOUTHERN STATES.

During several seasons I have had ample opportunity to study this imperfectly understood group in the field and have made observations on all except one of the species recognized in the appended revision. As far as I can see, the forms hitherto considered as varieties of other species are abundantly distinct and should be treated as species. Mr. Nash came to the same conclusion during his field-work in Florida. The diagnostic characters are brought out in the following key and descriptions.

* Bull. Torr. Club, 21: 305.

Corolla campanulate or globose campanulate; leaves destitute of sticky resin.

Stems horizontal, underground, the branches erect.

Pubescence consisting of gland-tipped hairs.

Twigs and racemes pilose.

1. *G. dumosa*.

Twigs and racemes bristly-hispid.

2. *G. hirtella*.

Pubescence consisting of simple non-glandular hairs.

Leaves glaucous, glabrous or nearly so.

3. *G. nana*.

Leaves densely tomentose, especially beneath.

4. *G. tomentosa*.

Stems erect, the branches spreading.

Leaves leathery, obtuse or retuse; drupe glaucous.

5. *G. frondosa*.

Leaves thin, acuminate and apiculate; drupe black.

6. *G. ursina*.

Corolla conic; leaves sticky with a resinous secretion.

7. *G. resinosa*.

I. GAYLUSSACIA DUMOSA (Andr.) T. & G.

Vaccinium dumosum Andr. Bot. Rep. 8: 112. 1794.

Gaylussacia dumosa T. & G.; A. Gray, Man. 259. 1848.

A low shrub, 1–5 dm. tall, with underground stems and erect solitary or tufted branches; the twigs, leaves and inflorescence glandular-pilose. Leaves leathery, the blades oval, obovate or oblanceolate, rarely linear-oblanceolate, 2–4 cm. long, apiculate at the apex, ciliate, short-petioled, deep green above, paler beneath; calyx glandular, about 5 mm. broad, the segments triangular or triangular ovate, acute, about as long as the tube; corolla campanulate, 5–6 mm. long, white or pink, wax-like, the segments broadly ovate, more or less recurved and revolute; filaments short, pubescent; anthers longer than the filaments, prolonged into fili-form tubes; drupe globose, black, 6–8 mm. in diameter, commonly somewhat pubescent.

In sandy soil, Newfoundland and along the coast to New York, south to eastern Pennsylvania, North Carolina, Florida and Louisiana. Spring; matures its fruit in the summer.

2. GAYLUSSACIA HIRTELLA (Ait.) Klotzsch.

Vaccinium hirtellum Ait. Hort. Kew. Ed. 2. 2: 357. 1811.

Gaylussacia hirtella Klotzsch, Linnaea, 14: 48. 1840.

Gaylussacia dumosa var. *hirtella* A. Gray, Man. 259. 1848.

A shrub, with underground stems, the branches, twigs and inflorescence bristly-hispid, the tips of the hairs with minute glands; leaves firm, the blades oblanceolate-spatulate or elliptic, 3–6 cm. long, apiculate, glandular-ciliate sparingly hispid above, short-petioled; racemes many-flowered; calyx hispid, 6 mm. broad, the segments triangular, rather acuminate, about as long as the tube; corolla broadly campanulate, 7–8 mm. long, the segments broader than long, the tips recurved, the edges revolute; filaments short,

pubescent; anthers longer than the filaments, prolonged into filiform tubes; drupe not seen.

In sand, Florida to Louisiana. Spring; fruit ripe in the summer.

Certainly distinct from *Gaylussacia dumosa*, from which it differs in habit, size and leaf characters. The pubescence is always diagnostic, the corolla is larger and much thinner than that of *G. dumosa*, while the calyx-segments are longer and usually acuminate.

3. GAYLUSSACIA NANA (A. Gray).

Gaylussacia frondosa var. *nana* A. Gray, Syn. Fl. N. A. Ed. 2: Pt. 1, 396. 1886.

A low glaucous shrub 1-4 dm. tall, spreading by underground stems. Leaves leathery, the blades elliptic, obovate or nearly spatulate, 2-3 cm. long, obtuse or minutely apiculate at the apex, glaucous on both sides, becoming bright green above, prominently rugose and sprinkled with amber-colored resin beneath, short-petioled; racemes few-flowered; pedicels slender, puberulent when young; calyx glabrous, 3 mm. broad, the segments triangular, acute, about as long as the tube; corolla globose-campanulate, 3 mm. long, the segments ovate, acutish, longer than broad; filaments short, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupes subglobose, 6-7 mm. in diameter, rather dry, glaucous.

In sandy pine barrens, Georgia to Florida and Alabama. March to April; matures its fruit in the summer.

Easily distinguished from *Gaylussacia frondosa*, with which it has been associated, by its very glaucous foliage and strongly rugose and much smaller leaves, besides its peculiar underground stems.

4. GAYLUSSACIA TOMENTOSA Pursh.

Gaylussacia frondosa var. *tomentosa* A. Gray. Syn. Fl. N. A. 2: Pt. 1, 19. 1878.

Gaylussacia tomentosa Pursh; A. Gray. Syn. Fl. N. A. 2: Pt. 1, 19. As synonym. 1878.

A low shrub, spreading by underground stems, the foliage tomentose with brownish hairs. Leaves leathery, the blades oblong or elliptic, often slightly broadest above the middle, 2.5-7 cm. long, obtuse and apiculate at the apex or sometimes notched, brown-tomentose on both sides, densely so beneath, short-petioled;

racemes few-flowered; pedicels 1–1.5 cm. long, much longer than the bracts; calyx glabrous, about 3.5 mm. broad, the segments ovate, acute, about as long as the tube; corolla campanulate, 3.5 mm. long, the segments ovate, obtuse, about as long as broad, the tips recurved, the edges revolute; filaments dilated, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupes depressed-globose, 8–9 mm. in diameter, glaucous.

In sandy soil, Georgia and Florida. Spring; matures its fruit in the summer.

Like the preceding species, *Gaylussacia tomentosa* has underground stems, but it differs from it in the brown-tomentose foliage, more robust habit, larger leaves and different leaf-form. The fruit of *G. tomentosa* is larger and much more fleshy than that of *G. nana*.

5. *GAYLUSSACIA FRONDOSA* (L.) T. & G.

Vaccinium frondosum L. Sp. Pl. 351. 1753.

Gaylussacia frondosa T. & G.; Torr. Fl. N. Y., 1: 449. 1843.

An irregularly branched shrub 1–2 meters tall, with puberulent twigs and young leaves. Leaves firm, the blades oblong-oblan-ceolate, ovate, oval or obovate, obtuse or notched at the apex, delicately revolute, short-petioled, bright green and glabrate above, glaucous and sprinkled with minute golden globules of resin beneath; racemes loose; pedicels long and slender; calyx glabrous, 3–4 cm. broad, the segments triangular, acute or acutish, about as long as the tube; corolla globose-campanulate, about 4 mm. long, green to purplish, the segments triangular, broader than long, recurved and revolute; filaments dilated, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupe globose, 8–10 mm. in diameter, with a pale bloom.

In sandy soil, New Hampshire, south to Florida, Kentucky and Louisiana. Spring; matures its fruit in the summer.

6. *GAYLUSSACIA URSINA* (M. A. Curtis) T. & G.

Vaccinium ursinum M. A. Curtis, Am. Journ. Sci. 44: 82. 1843.

Gaylussacia ursina T. & G.; A. Gray, Mem. Am. Acad. (II.) 3: 49. 1846.

A straggling branching shrub, 6–15 dm. tall, with sparingly pubescent twigs and young foliage. Leaves thin, the blades oblong, elliptic or oblanceolate, usually rhomboidal, 4–10 cm. long, usually short-acuminate; apiculate, ciliate, deep green above, paler beneath, pubescent on the nerves on both sides, obtuse or rounded at the base, short-petioled; flowers few, in lateral somewhat drooping racemes; calyx with numerous golden glands, about 3 mm.

broad, its 5 segments very low, obtuse, several times shorter than the tube; corolla globose-campanulate, greenish-white or tawny-red, about 4-5 mm. long, its segments triangular, acutish, recurved, revolute; filaments dilated, pubescent, incurved at the apex, longer than the anthers which have short tubes at the apex; drupe globose, 10-12 mm. in diameter, black, shining, sweet.

In deep forests on the mountains, North Carolina to northern Georgia. Spring; matures its fruit in the late summer.

7. *GAYLUSSACIA RESINOSA* (Ait.) T. & G.

Vaccinium resinosum Ait. Hort. Kew. 2: 12. 1789.

Gaylussacia resinosa T. & G.; Torr. Fl. N. Y. 1: 449. 1843.

A rigid branching shrub 3-12 dm. tall, its twigs and foliage more or less pubescent and sticky with a resinous secretion when young, leaves firm, the blades elliptic, oval or oblong, sometimes broadest above the middle, firm, obtuse or apiculate, entire, ciliate, short petioled; flowers in lateral drooping racemes; pedicels 2-8 mm. long, usually with two narrow bracts; calyx about 2 mm. broad, its 5 segments ovate, obtuse, about as long as the tube; corolla obconic, red or reddish-green, 5-6 mm. long, more or less constricted near the apex, the segments ovate, spreading or recurved, revolute, obtuse; filaments winged, pubescent, shorter than the anthers, each cavity of which is prolonged into a tube; drupes globose, 6-10 mm. in diameter, black or rarely white, sweet.

In rocky woods and hillsides, Newfoundland to the Saskatchewan, south to Georgia. Spring; matures its fruit in the summer.

Shrubs and Trees of the Southern States.—III.

BY JOHN K. SMALL

1. HITHERTO UNDESCRIBED SPECIES

Prunus Cuthbertii

A tree 6 m. tall and sometimes 1.5 dm. in diameter near the base, with tomentose twigs. Leaf-blades leathery, normally obovate, varying to oval or fiddle-shaped, 4–9 cm. long, blunt or notched at the apex, shallowly serrate, not markedly biglandular at the often cuneate base, dull green above, pale or glaucescent beneath, the midrib and petioles copiously tomentose and the lateral veins slightly so: racemes 5–8 cm. long, terminating short leafy branches, the rachis and pedicels pubescent like the twigs: pedicels clavate, 3–5 mm. long during anthesis, becoming 8–11 mm. long: sepals broader than long, obtuse, shorter than the hypanthium: petals suborbicular, about 2 mm. in diameter, crisped: drupes subglobose, mostly 8–9 mm. in diameter, red.

In rich woods, near Augusta, Georgia.

A relative of *Prunus serotina* differing in the decidedly obovate blunt leaf-blades and the tomentose glandless petioles and tomentose veins of the blades and the similarly pubescent racemes. The flowers are smaller and the very blunt sepals are much broader than the acute sepals of *P. serotina*. The fruit also furnishes a character in its decidedly red color. The original specimens were collected by Mr. A. Cuthbert in the vicinity of Augusta, Georgia, on July 17, 1898, and June 2, 1899. Type in the herbarium of the New York Botanical Garden.

Leucothoe platyphylla

A straggling shrub 0.5–1 m. tall, with spreading and drooping branches. Twigs and branches finely pubescent: leaf-blades suborbicular to oval, broadly oblong or oblong-ovate, 5–8 cm. long, abruptly pointed or slightly acuminate, serrate with very fine spinulose teeth, especially above the middle: petioles stout, 4–8 mm. long, pubescent: racemes 2–5 cm. long, the rachis pubescent like the twigs: pedicels 3–5 mm. long: calyx glabrous; longer sepals orbicular-ovate: corolla white, 6–8 mm. long: capsule 5.5 mm. broad, 4 mm. high.

In low thickets, Georgia to Alabama. Spring.

Leucothoë platyphylla differs from *L. axillaris* in its broader leaf-blades, orbicular larger sepals, smaller corollas and larger capsules.

The specimens on which the species is founded were collected by the writer near the Ochlockonee River about Thomasville, Georgia, in May and June, 1895. Type in the herbarium of Columbia University.

Hypericum splendens

An erect much branched shrub 0.5–1.5 meters tall, with 2-edged glaucous twigs. Leaves firm, numerous; blades oblong, 1.5–2.5 cm. long, obtuse or rounded at the apex, slightly revolute, glaucous, especially beneath, narrowed at the sessile base: buds conic: flowers very showy, several or many in terminal or axillary cymes: sepals unequal, oblong, firm, apiculate, the outer about 8 mm. long, the inner 5 mm. long: corollas 3.5–4 cm. broad: petals golden, cuneate, oblique, 1.5–2 cm. long: stamens very numerous, orange-colored: styles 3, slender: capsules often crowded, conic, 1.5 cm. high, acuminate at the apex, partially 3-celled, about thrice as long as the sepals with 3 narrow wings and 6 obtuse angles: seeds cylindric, 1.3 mm. long, longitudinally ribbed and transversely wrinkled, resembling ears of corn.

On granite slopes, Stone Mountain, Georgia. Summer.

This is perhaps the most showy North American *Hypericum* and is related to *H. aurum* from which it differs in the smaller firmer leaves, the more distinctly pedicelled flowers and the conic buds.

The original specimens were collected by the writer on Stone Mountain, Georgia, in July and August, 1893, and August 6, 1895. Type in the herbarium of Columbia University.

2. THE GENUS PTELEA IN THE SOUTHEASTERN UNITED STATES

PTELEA L.

The genus *Ptelea* differs from *Helietta*, its only close relative in North America, in its pubescent filaments, and in the fruit which is winged all around and does not separate into distinct carpels.

Key to the Species

Parts of the flower usually in 5's: leaflets relatively small.

Filaments slightly pubescent at the middle: petals glabrous within: Floridian.

1. *P. Baldwinii*.

Filaments pubescent throughout : petals pubescent within : Texano-Mexican.

2. *P. angustifolia*.

Parts of the flower usually in 4's : leaflets relatively large.

Samaras obovate.

Leaflets with sharply serrate blades : samaras 16-19 mm. long, acute at the base, the body merely glandular-dotted.

3. *P. serrata*.

Leaflets with entire or merely undulate blades : samaras 8-11 mm. long, or rarely longer, rounded or truncate at the base, the body pitted.

4. *P. microcarpa*.

Samaras suborbicular.

Leaflets with entire or merely crenulate blades, the terminal one much longer than broad, acute or slightly acuminate.

5. *P. trifoliata*.

Leaflets with crenate or crenate-lobed blades, the terminal one only slightly longer than broad, blunt.

Blades of the leaflets not lustrous : filaments nearly glabrous : anthers rounded or retuse at the apex.

6. *P. rhombifolia*.

Blades of the leaflets lustrous above : filaments densely pubescent below : anthers apiculate.

7. *P. Toxicodendron*.

1. PTELEA BALDWINII T. & G.

A shrub about 3 dm. tall, with irregularly branched stems. Leaflets 3 ; blades oval or ovate, 1-2 cm. long, obtuse at both ends, or the terminal one cuneate at the base, sessile, glabrous except the midrib and the ciliate margins when they are young : panicles few-flowered : flowers with the parts mostly in 5's : calyx 1.5 mm. broad : sepals oval, less than 1 mm. long, acutish, ascending : petals 4, oblong-oblancheolate, 4 mm. long, obtuse, undulate : stamens shorter than the petals : filaments stout, hairy at the middle.

In the vicinity of St. Johns, eastern Florida. Spring.

2. PTELEA ANGUSTIFOLIA Benth.

A little known species originally described from Mexico, with pubescent foliage, wholly pubescent filaments and pubescent petals, is said to occur in southern and western Texas.

3. Ptelea serrata sp. nov.

An irregularly branched shrub, 1-2 m. tall, with glabrous foliage. Leaflets 3 ; blades thinnish, oval, elliptic or elliptic-obovate, 2.5-7 cm. long, sharply acuminate, or rarely only acute, rather shallowly but sharply serrate, deep green above, very pale green beneath, the terminal one with a slender base : panicles few-flowered : samaras obovate, 16-19 mm. long, acute at the base, the wing rather delicate, the body glandular-dotted.

On granite slopes, Stone Mountain, Georgia. Spring.

Ptelea serrata is not closely related to any described species. It differs from the other species in the sharply acute or acuminate and sharply serrate blades of leaflets and the obovate samaras with their acute bases.

The specimens on which the species is founded were collected by the writer on Stone Mountain, Georgia on July 3, 1893. Type in the herbarium of Columbia University.

4. *Ptelea microcarpa* sp. nov.

A shrub 1.5–3 m. tall, with branching stems and glabrous foliage. Leaflets 3; blades firm, elliptic, oval or oblong-lanceolate, 4–10 cm. long, bluntly pointed or acutish, often slightly acuminate at both ends, entire or nearly undulate, slightly paler beneath than above, the terminal one not conspicuously narrowed at the base: panicle many-flowered: samaras suborbicular or orbicular-obovate, 8–11 mm. in diameter, or rarely larger, rounded or truncate at the base, the wings slightly crisped, the body pitted.

On limestone or granite ridges, Tennessee, Georgia and Alabama. Spring.

Ptelea microcarpa is most closely related to *P. serrata*, but differs in the firmer longer entire or merely undulate blades of the leaflets, and the samara with its pitted body, and the wing which is rounded or truncate at the base.

The original specimens were collected by officers of the Biltmore Herbarium (no. 4437^b), at Nashville, Tennessee, August 9, 1897. The type is in the herbarium of the New York Botanical Garden.

5. *PTELEA TRIFOLIATA* L.

An aromatic shrub or tree sometimes 8 m. tall, the foliage glabrous or sometimes densely pubescent. Leaflets 3; blades ovate, oval, elliptic, oblong, oblong-lanceolate or oblanceolate, 4–12 cm. long, acute or acuminate, entire or sometimes undulate or partially crenulate: panicles many-flowered: sepals ovate, 1.5 mm. long, obtuse: petals narrowly oblong, 4–5 mm. long: samaras suborbicular or oval-orbicular, 2–2.5 cm. long, rounded or notched at the base.

In rich soil and on river banks, Long Island to Ontario, Minnesota, Florida and Texas. Spring. The form with pubescent foliage is *Ptelea trifoliata mollis* M. A. Curtis and is most common in the Gulf States.

6. *PTELEA RHOMBIFOLIA* Heller

A shrub 2-2.5 m. tall, branching above, the foliage densely pubescent. Leaflets 3; blades rhombic-ovate to rhombic-orbicular, 2.5-5 cm. long, blunt, crenate, dull green above, the terminal one but little longer than broad: petals pubescent without, about 4 mm. long: filaments slightly pubescent near the base: samaras nearly orbicular, 1.5-2.5 cm. broad.

In open woods, southern Texas. Spring.

7. *Ptelea Toxicodendron* sp. nov.

A branching shrub 1-2 m. tall, with glabrous foliage. Leaflets 3; blades oval or rarely oval-ovate, 1.5-6 cm. long, rounded or blunt at the apex, crenate or somewhat crenate-lobed, dark green and lustrous above, slightly paler beneath: panicles few-flowered: petals about 5 mm. long, glabrous: filaments densely pubescent below: mature fruit not seen.

In gravelly soil, near Kerrville, Texas. Spring.

A species most closely related to *Ptelea rhombifolia*, but easily distinguished by its glabrous or nearly glabrous leaflets whose blades are lustrous above, the filaments which are densely pubescent below and the apiculate anthers.

The original specimens were collected by Mr. A. A. Heller at Kerrville, Texas, and distributed in his Plants of Southern Texas, under no. 1690. Type in the herbarium of Columbia University.

Shrubs and Trees of the Southern States.—IV.

BY JOHN K. SMALL

1. THE EBENACEAE IN THE SOUTH

Two types with as divergent characters as those possessed by *Diospyros Virginiana* and the so-called *D. Texana*, cannot with the least degree of systematic order, be referred to the same genus. The two plants are of wholly different habit, and the flower-structure of the two is so distinct that I cannot understand on what grounds they have been associated with each other in the same genus. The distinguishing characters of the two trees, which I shall treat as two distinct genera, may be compared by means of the following synopsis :

EBENACEAE

A family of about 6 genera and 275 species, most abundant in tropical regions. Only the following representatives are now known to occur in the United States.

Key to the Genera

Styles distinct : anther-sacs opening by longitudinal slits : filaments pubescent : pistillate flowers without staminodia. **1. DIOSPYROS.**

Styles united : anther-sacs opening by subapical pores ; filaments glabrous : pistillate flowers with 8 staminodia. **2. BRAYODENDRON.**

1. DIOSPYROS L.

1. *D. VIRGINIANA* L. Sp. Pl. 1057. 1753

In woods and fields, Rhode Island to Kansas, Florida and Texas. As now limited this species may be an aggregate. One or two additional species may be separable in the south Atlantic and Gulf States.

2. *Brayodendron* *

1. *B. Texanum* (Scheele)

Diospyros Texana Scheele, Linnaea, 22 : 145. 1849.

Along or near streams in river valleys, southern Texas and adjacent Mexico.

* Named for Prof. W. L. Bray, head of the School of Botany, University of Texas.

2. HITHERTO UNDESCRIBED SPECIES

Quercus microcarya

A shrub, or a small tree sometimes 5 m. tall, with very smooth branches and glabrous foliage. Leaves deciduous; blades thin, spatulate in outline, 5–10 cm. long, undulate or shallowly lobed, gray-green above, yellowish green beneath, short-petioled, the small bristles terminating the lobes early deciduous: acorns sessile, less than 10 mm. long; cup deep saucer-shaped, 6–7 mm. broad; nut globose-ovoid, often nearly one-half included in the cup.

On granite outcrops, Little Stone Mountain, Georgia.

Related to *Q. nigra*, but more delicate in all its parts. The leaf-blades are relatively thin and more irregularly lobed, while the very small acorns, always, as far as I have observed, less than 10 mm. in length, with their relatively deep saucer-shaped cups, are very distinct from the larger fruit of *Q. nigra* with its very shallow cup. The fruit is much smaller than that of any of the species of the group to which this plant belongs.

The original specimens were collected by the writer on Little Stone Mountain, Georgia, September 11, 1894. Type in the herbarium of the New York Botanical Garden.

Quercus fusiformis

A shrub 1.5–3 m. tall, with slender or switch-like stems or branches. Leaves persistent; blades leathery, oblong or ovate-oblong, 3–5 cm. long, entire or sparingly spiny-toothed on the twigs, gray-green and lustrous above, paler and scurfy-tomentose beneath, slightly revolute, rounded or truncate at the oblique base, short-petioled: acorns numerous, solitary or several on slender peduncles; cup turbinate, 10–12 mm. high, gray; nut fusiform, 2–2.5 cm. long, acute, conspicuously striate, thrice surpassing the cup.

On arid limestone and granite hills, central Texas.

Quercus fusiformis belongs to the group formed by *Q. minima*, *Q. geminata* and *Q. Virginiana*. It is most closely related to *Q. Virginiana*, but differs in the much elongated acorn with its turbinate cup and fusiform nut.

The original specimens were collected on Lacey's Ranch near Kerrville, Texas, by Mr. Howard Lacey during the years 1899–1900, and given to me by Professor W. L. Bray, of the University of Texas. Locally known as LIVE OAK. Type in the herbarium of the New York Botanical Garden.

Quercus Laceyi

A shrub or small tree, becoming 6 m. tall, with a rough deeply and irregularly grooved bark. Leaves deciduous but rather tardily so, numerous; blades oblong and with 3-5 shallow lobes, or oblong-obovate and more prominently 3-lobed below the apex, 4-8 cm. long, olive-green and with a waxy lustre above, grayish and slightly and minutely scurfy beneath, sometimes truncate or subcordate at the base, short-petioled; acorns sessile or nearly so; cup shallowly saucer-shaped, very thick and corky; nuts oblong to oblong-ovoid, 15-19 mm. long, often depressed at the apex; seed very bitter.

On the summits of Caprina limestone hills, north-central Texas.

Related to *Q. breviloba* but differing markedly in the glabrous leaves, the thick corky coarsely warty cup of the acorn and the oblong or ovoid-oblong nut.

The original specimens were collected on Lacey's Ranch near Kerrville, Texas, by Mr. Howard Lacey during the years 1899-1900, and given to me by Professor W. L. Bray, of the University of Texas. Locally known as BASTARD OAK. Type in the herbarium of the New York Botanical Garden.

Quercus Brayii

A large tree sometimes 18 m. tall, or more, with a pale flaky bark. Leaves very numerous, deciduous; blades thin, cuncate, 10-20 cm. long, abruptly acuminate at the apex, regularly and coarsely sinuate-toothed nearly to the base, glabrous, with relatively few, prominent and regularly placed lateral ribs, deep green above, slightly paler and rather olive-green beneath; petioles 1.5-2.5 cm. long; acorns sessile or nearly so; cup hemispheric, 2-2.5 cm. broad, the lower scales somewhat warty on the back; nut oblong or ovoid, 2.5-3 cm. long, about 1.5 cm. thick; seed rather sweet.

In cañons, central Texas.

Quercus Brayii is most closely related to *Q. Michauxii*, but differs conspicuously in the membranous and glabrous leaf-blades with their few coarse teeth and lateral ribs, and the shorter and warty-thickened scales of the cup of the acorn. The original specimens were collected on Lacey's Ranch near Kerrville, Texas, by Mr. Howard Lacey in the years 1899-1900, and sent to me by Professor W. L. Bray. It is locally known as WHITE OAK. Type in the herbarium of the New York Botanical Garden.

AEsculus austrina

A shrub several meters tall, with pubescent foliage and inflorescence. Leaf-blades 1-3 dm. broad, long-petioled; leaflets 3-5, firm or leathery, oval or oval-ovate, short-acuminate at both ends or acute at the oblique base (except in the case of the terminal one), lustrous and glabrate above, except on the tomentose nerves, densely tomentose beneath, sharply serrate, commonly quite long-petioluled: panicles 1-1.5 dm. long, tomentose: flowers deep red, about 3 cm. long: calyx tubular, red, 10-14 mm. long, glabrous; lobes ovate, rounded: petals minutely glandular, those of the upper pair with oval blades about as long as the slightly villous claws, those of the lateral pair with obovate blades which are exceeded several times in length by their claws: stamens exerted; filaments sparingly villous.

In low grounds, Louisiana.

Most closely related to *AEsculus Pavia*, from which it differs in the foliage and flowers. It is *AEsculus Pavia* β *discolor* of Torrey and Gray,* in part, but not the *AEsculus discolor* of Pursh.† Torrey and Gray's disposition of this plant is the most nearly correct interpretation we have yet had. Dr. Gray later referred it to his *AEsculus flava* var. *purpurascens*, a species with which it has but distant relationship.

The specimen on which the species is founded was collected in Louisiana by Dr. Hale and is preserved in the herbarium of Columbia University.

Hypericum interior

A much branched shrub, several dm. tall, with sharply angled branches and glabrous foliage. Leaves rather numerous; blades narrowly oblanceolate to narrowly linear-ob lanceolate, 1-3 cm. long, acute, slightly revolute, pale beneath, narrowed into slender petioles: panicles many-flowered: sepals linear or narrowly oblong, 3-4 mm. long, acute, rather rigid, more or less spreading at maturity: corollas yellow, about 1 cm. broad: petals obovate or cuneate-obovate: capsules conic-ovoid, 5 mm. long.

Along streams, Tennessee and Texas. Summer.

A shrubby species related to *Hypericum galioides*, but more corymbosely branched, and with broader leaf-blades. The sepals

* Fl. N. A. 1: 252.

† Fl. Am. Sept. 254.

are characteristic, being linear or nearly so, instead of manifestly narrowed to the base. The following specimens belong here :

TEXAS: [no locality], *Veatch*.

TENNESSEE: near Dandridge, July, 1842, *Rugel*:—type, in the herbarium of Columbia University.

Azalea candida

A rigid shrub 1-2 m. tall, with wide-branching stems and white-tomentose young foliage, or the twigs sometimes brownish. Leaves numerous; blades leathery, obovate, oblanceolate or oblong, 1-5 cm. long, acute or apiculate, ciliate, somewhat revolute, thinly tomentose above, densely white-tomentose and somewhat reticulated beneath, short-petioled: corymbs several-flowered: pedicels canescent and copiously glandular-pubescent: calyx-lobes pectinate-ciliate: corolla rose-colored or pinkish, 3-3.5 cm. long: capsules 1.5-2 cm. long, canescent, curved, longer than their pedicels, often twice as long.

In hammocks and river swamps, southern Georgia. Spring.

Related to *Azalea nudiflora*, but easily distinguished by the copious soft pubescence of the twigs, the white-tomentose leaf-blades, the smaller flowers and the smaller softly and closely pubescent capsules. Collected by the writer along the Withlocoche River about Valdosta, Georgia, June 6-12, 1895. Type in the herbarium of Columbia University.

Dendrium Hugerii

An evergreen shrub 2-4 dm. tall, with erect much branched stems. Leaves mainly alternate; blades leathery, oblong, 1-1.5 cm. long, lustrous and dark green above, paler beneath, obtuse, revolute, somewhat obliquely narrowed into petioles 1-2 mm. long: flower-clusters dense: bracts oblong-ovate, 3 mm. long, obtuse: pedicels 5-10 mm. long, minutely glandular: calyx nearly glabrous; lobes lanceolate, about 1 mm. long, acute: corolla white; lobes ovate, 4 mm. long, obtuse: filaments club-shaped, as long as the corolla-lobes: capsules ovoid, 4-4.5 mm. long, glabrous or nearly so, obtusely lobed, twice as long as the calyx-lobes, abruptly contracted into the stoutish style which is about as long as the capsule-body.

On cliffs and rocky mountain summits, North and South Carolina. Spring and early summer.

This overlooked species is most closely related to *Dendrium*

buxifolium of the Atlantic pine lands ; it is, however, larger throughout and more erect. It may readily be separated by the large leaves, the filaments, which are about as long as the corolla-lobes, and the large capsule, which is about twice as long as the calyx-lobes.

NORTH CAROLINA : Top of Hibriten Mountain, Lenoir, Sept., 1896, *A. M. Huger*. Table Rock, *S. B. Buckley*; *Small & Heller*, 1891.

SOUTH CAROLINA : Top of Table Mountain, August, 1896, *J. K. Small*:—type, specimen in the herbarium of Columbia University.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 19.

THE AMERICAN SPECIES OF LIMNORCHIS
AND PIPERIA, NORTH OF MEXICO

BY PER AXEL RYDBERG.

NEW YORK

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The American Species of *Limnorchis* and *Piperia*, north of Mexico

BY PER ANEL RYDBERG

In revising the manuscript of the Orchidaceae for Dr. Britton's Manual of the Flora of the Northern States and at the same time that of my Catalogue of the Flora of Montana and the Yellowstone Park,* I came to the conclusion that the genus *Habenaria* as treated in America was an altogether too diversified genus and contained species of very distant relationship. In Europe, as a rule, several genera are admitted. Prof. E. Pfitzer, who prepared the Orchidaceae for Engler and Prantl's *Die natürlichen Pflanzenfamilien*, places the North American *Habenariæ* in the following genera: *Cocloglossum*, *Gymnadenia*, *Platanthera*, *Perularia* and *Habenaria*. Kraenzlin in his *Orchidacearum Genera et Species*, admits *Habenaria*, *Gymnadenia* and *Platanthera*. Both these authors place *Habenaria* in a separate subtribe from the rest. The true *Habenariæ* are represented in North America by only a few species in the Gulf States, West Indies, Mexico and Central America. They are characterized by the long filiform appendages of the stigmas, anthers and petals. *Platanthera* as understood by Pfitzer is still a very complex genus and had he known the American forms as well as those represented in Europe, he undoubtedly would have restored Rafinesque's *Blephariglottis* for our fringed orchids and established a few more genera. During last July I stayed a few days in London and met Mr. Rolfe, the authority on orchids at Kew. He expressed the opinion that *Habenaria* must be split up, not only so that *Gymnadenia* and *Platanthera* should be taken out, but that all three genera should be subdivided. In one instance he went farther than I had dared, viz., expressing the opinion that *Orchis rotundifolia* perhaps should be removed from *Orchis*.

When doing my work referred to above, I came to the conclusion, that if *Cocloglossum* and *Perularia* should be admitted, certain other groups represented wholly by American species must be

* Mem. N. Y. Bot. Garden, Vol. I.

taken out of *Platanthera* and *Gymnadenia*. I therefore described in my Catalogue of the Flora of Montana the new genera *Lysiclla* and *Limnorchis* and in Dr. Britton's Manual *Gymnadeniopsis*.* In the latter I also reëstablished *Blephariglottis* Raf. In the Bulletin of the Torrey Botanical Club,† I added another genus, *Piperia*. Of these, no species belonging to *Gymnadeniopsis*, *Blephariglottis* or *Piperia* are mentioned by Pfitzer, which shows that he was not well acquainted with these plants.

This revision is based on the material found at the New York Botanical Garden together with a few specimens cited from the Canby Herbarium. A few of the *Habenariac*, described from Mexico and Central America may belong to *Limnorchis* or *Piperia*. I have not seen, however, any species from there referable to either genus, but as several are unknown to me I have limited my work to the North American species growing north of Mexico. One of the Siberian specimens in the Columbia University herbarium is evidently a *Limnorchis*, but as it is wrongly named and rather scrappy, I have left it without consideration.

The illustrations are drawn by the writer and represent two views of each species on a scale twice the natural size.

LIMNORCHIS Rydb. Mem. N. Y. Bot. Gard. 1: 104. 1900

Leafy-stemmed plants with elongated fusiform root-like tubers and fleshy-fibrous roots: flowers whitish or greenish or tinged with purple; upper sepal ovate to almost orbicular, erect, 3-7-nerved but usually 5-nerved; lateral sepals from linear to ovate-lanceolate, free from the lip, 3-nerved, seldom 4-5-nerved, spreading or often somewhat reflexed; upper petals erect, usually slightly shorter than the upper sepal, from narrowly to broadly lanceolate, 3-nerved, oblique at the base and semi-cordate, that is cordate on the lower side; lip entire, usually indistinctly nerved, flat or slightly concave, reflexed, free, not clawed, from linear to rhombic-lanceolate, obtuse; column short and thick; anther-cells parallel, opening in front; stigma broadly triangular; ovary sessile, in fruit elongated ellipsoid.

The mode of propagation in many orchids is very peculiar. Near the base of the stem is produced a short offset, tuber-, corm- or root-like in appearance, usually fleshy. In the upper portion

* Wrongly printed as *Gymnadeniopsis*.

† 28: 269. 1901.

is a hidden bud, from which the stem of the following year will spring, the lower portion is often root-like, elongated, sometimes cleft and functions more or less as a root. What this offset should be called I do not know. It has been called both tuber and corm. The latter name is not applicable from the way in which it arises. This would indicate the name tuber, for it is really formed at the end of a short subterranean branch, but it has only one bud and this is directed towards the place from which the offset sprang. The distal end, which in common tubers usually bears most of the buds, is here often root-like. This is especially the case in *Limnorchis*, and here the offsets are usually taken for roots. It may be that the larger portion thereof really is a fleshy primary root (if the term primary root can be applied to an offset). The secondary roots are developed the next year at its top from the base of the bud.

The first species of *Limnorchis* was described as *Orchis hyperborca* Linn.* The description was drawn from a specimen from Iceland collected by König. About the same time a plant also collected by König (and probably the same as the type of *O. hyperborca*) was figured in *Flora Danica* without a binominal name. The description accompanying this is a little faulty because it does not agree with the plate nor with any plant known. This description was copied by Retzius† and he gave it the name *Orchis Koenigii*. *Orchis hyperborca* L. is fairly common on Iceland and Greenland but rare on the American continent. Another plant closely related to it but larger and with shorter and more clavate spur has been confounded with it. In preparing the revision of Dr. Britton's manual I had not distinguished the two and the description of the spur refers principally to the larger plant. At my visit to the Botanical Garden at Copenhagen last summer, I first saw good material from Greenland and Iceland, and then I noticed the difference between the two plants. The larger plant has been named *Platanthera hyperborca* β *major* Lange‡ and *Platanthera Koenigii* Lindl;§ but it is evidently not *Orchis Koenigii* Retz.

* Linn. Mant. 121. 1767.

† Fl. Scand. 1: 168. 1779.

‡ Consp. Fl. Groenl. 118. 1880.

§ Gen. et Sp. Orchid. Pl. 286. 1835.

In *Habenaria hyperborca* R. Br. or *Platanthera hyperborca* Lindl. there have been included several other forms, as for instance *Orchis Huronensis* Nutt.* (*Platanthera Huronensis* Lindl. l. c. 288), *O. dolichorhiza* Fisch.† and *Habenaria borealis* § *viridiflora* Cham.‡ All three, I think, are good species and they were so regarded by Lindley. The first is common in the northeastern America. In Britton's manual it appeared under the name *Limnorchis Huronensis* (Nutt.) Rydberg.§ I also described another species of the same group as *L. media*. That there were at least three distinct forms of the *L. hyperborca* group in the northeastern United States, I have not been the only one to notice, for Professor Peck || recognized three growing in the same meadow. I did not see his report before the page proofs of the manual had already gone to the printer, but had come to the same conclusion independently. As the *L. hyperborca* of my treatment there contains in my opinion now two species, as I have stated before, the number of the group in the northeastern United States becomes four, and, together with three species of the *L. dilatata* group, our eastern species become seven.

Habenaria borealis § *viridiflora* Cham. is common throughout the Rocky Mountain region, the Columbia valley and the northern part of the Pacific coast. It is without doubt closer related to the true *L. hypoborca* than any of the other species and differs mainly in the light green flowers and the short clavate spur.

Orchis dolichorhiza (*Platanthera Koenigii* § *dolichorhiza* Lindl. l. c. 287), I have not seen, but from the description it must be distinct from either. This was from the island of Unalaska.

The second in order of the North American species of *Limnorchis* described was published under the name *Orchis dilatata* Pursh¶ (*Limnorchis dilatata* Rydb.**). It is a common plant of the northeastern part of this country. Most of the specimens so named from the Rockies and the west coast belong to *Habenaria borealis* Cham.††

* Gen. N. Am. Pl. 2 : 189. 1818.

† Lindl. l. c. 287, as a synonym.

‡ Linnaea 3 : 28. 1828.

§ Britt. Man. Fl. Northern States and Can. 294. 1901.

|| See Peck, Regent's Rep. 50 : 126. 1897.

¶ Fl. Am. Sept. 588. 1814.

** Britton, Man. Fl. N. St. 294. 1901.

†† Linnaea 3 : 28. 1828.

(*Limnorchis dilatatiformis* Rydb.*). This differs from *L. dilatata* mainly in the shorter, more clavate spur, the dull or greenish white flowers and the usually smaller size. It approaches much the form referred to above under *L. hyperborea* viz. *Habenaria borealis* & *viridiflora* Cham., and in fact connects the *L. hyperborea* and the *L. dilatata* groups. The other specimens from the West labeled *Habenaria dilatata* belong to *L. leucostachys* and a few of the new species described below. No specimen of *L. dilatata* has been seen from any place west of Minnesota.

Lindley in his *Genera and Species of Orchideous Plants* described the following species which fall within the limits of *Limnorchis*: *Platanthera convallariaefolia*, *P. leucostachys*, *P. gracilis*, *P. stricta* and *P. graminea*. While staying at Kew in July this year, I had the privilege of seeing Lindley's herbarium as well as Douglas' plant preserved at Kew, which has enabled me to verify my determinations.

P. convallariaefolia was described from specimens collected in Kamtchatka by Fischer. It is a species resembling a slender *L. dilatata*, but the lip is linear, not at all dilated at the base, the spur is filiform and about the length of the lip and the lower leaves are oblanceolate and obtuse. In the Torrey herbarium there is a specimen communicated by Lindley. This is evidently a cotype of that in Lindley's own collection for the two are as like as they can be. In Torrey's herbarium there is also another specimen, collected on Unalaska, which I also refer here.

P. leucostachys was described from a specimen collected by Douglas. This is in the herbarium of the Kew Gardens. In this specimen the spur is slender, filiform, not at all thickened and not very obtuse at the apex. There is a form also common in the Columbia valley with the same habit but with the larger spur much more clavate and very obtuse at the apex. If this should be regarded as a form of *L. leucostachys* or as a distinct species is a question of which opinions may differ, but it is, however, important to know what the original *P. leucostachys* was.

P. gracilis is a slender plant with the white flowers of *L. dilatata*, but the lip is linear and the spur decidedly clavate. In reality it is nearest related to *P. convallariaefolia*, from which it dif-

* Mem. N. Y. Bot. Gar. 1: 105. 1900.

fers mainly in the spur. It is not at all the plant that has gone under the name *Habenaria gracilis* in the United States. This is the following species, belonging to another group of the genus. *P. gracilis* is confined to Alaska and subarctic America.

P. stricta is the tall species, with greenish or purplish flowers, linear lip and short saccate spur, that Watson and others have called *Habenaria gracilis*. This is common in the Columbia region and the valleys of the Rockies as far south as Colorado.

P. graminea resembles *P. gracilis* in habit, but the leaves are narrower and the lip dilated at the base, the spur is longer and more clavate. Its home is Alaska. It was first collected by Menzies, and later by Miss Cooley and by Gorman. A single specimen from the lower St. Lawrence region evidently is to be referred here also.

Hooker's *Flora Boreali-Americana* contains the same species as Lindley's *Genera*.

Watson, in the *Botany of California*, has in his second section of *Habenaria*, which section would correspond to *Limnorchis*, the following species: *H. leucostachys* (Lindl.) S. Wats., *H. sparsiflora* S. Wats., *H. pedicellata* S. Wats., *H. hyperborca* R. Br., *H. Coperi* S. Wats., and *H. gracilis* S. Wats.

In *H. leucostachys*, he includes *H. Thurberi* A. Gray,* but the flowers of this species are greener, the dilated portion of the lip oval instead of rhombic and the spur longer. Watson states the characters of Gray's *H. Thurberi* were mostly drawn from the variety mentioned (*i. e.*, the same as *H. sparsiflora*), a statement which is not correct.

H. sparsiflora Wats. is a good species, which, together with *H. brevifolia* Greene† and two more species, constitute a distinct group, perhaps a subgenus, distinguished by the very broad and thin connective.

H. pedicellata Wats. *l. c.* I have not seen, but from the description it cannot belong to *Limnorchis*.

H. hyperborca of the *Botany of California* is the same as *H. borealis* β *viridiflora* Cham. and not *O. hyperborca* L.

* Proc. Am. Acad. 7 : 389. 1868.

† Proc. Am. Acad. 12 : 276. 1876.

‡ Bot. Gaz. 7 : 218. 1881.

H. Cooperi Wats. *l. c.* is not a *Limnorchis*, but a *Piperia*.

H. gracilis Wats. is not the same as *Platanthera gracilis* Lindley, but *P. stricta* of the same author.

Kraenzlin's treatment in his *Orchidacearum Genera et Species* is altogether unsatisfactory. He admits only two species, *Platanthera gracilis* and *P. hyperborea*, the latter with several varieties.

His *P. gracilis* is, however, not *P. gracilis* Lindley but *Habenaria gracilis* Wats. (*P. stricta* Lindl.).

Under *P. hyperborea* a var. *genuina* he cites naturally also *Habenaria borealis* ♂ *viridiflora* Cham. as a synonym, but he has printed *viridis* instead of *viridiflora*. I take this, however, as a distinct species.

P. convallariaefolia he has reduced to a variety, *P. hyperborea* ♂ var. *convallariaefolia*. In the same manner, he calls *H. dilatata*, ♂ var. *dilatata* Lindl. (I do not think that Lindley ever made it a variety; Kraenzlin is very loose in citing authorities.) Under this variety he has as synonyms among others: *Platanthera Huronensis* Lindl., *Habenaria pedicellata* S. Wats., *H. Cooperi* S. Wats., *P. graminea* and *P. borealis* Reichenb. Of these the last named is the only one, that can be referred here with any reason, for that, which is the same as *Habenaria borealis* Cham., belongs to the *dilatata* group, while *P. Huronensis* belongs to the *hyperborea* group and *H. pedicellata* and *H. Cooperi* belong to distinct genera.

Under his ♂ var. *leucostachys* he has as synonyms besides *P. leucostachys* Lindl., also *Habenaria brevifolia* Greene, *P. Ghiesbreghtiana* Rich. & Gal., *P. sparsiflora* S. Wats., *P. Thurberi* v. Grayi S. Wats. and *H. flagellaris* S. Wats. Of these *Habenaria brevifolia* Greene and *H. sparsiflora* S. Wats. can under no conditions be referred to *H. leucostachys* on account of their broad connective. The habit of *H. brevifolia* alone should throw it out; there is scarcely a more distinct species in the whole family. As far as *H. sparsiflora* S. Wats. is concerned, it would have been more reasonable to refer that species to his *H. gracilis*, i. e., *H. stricta* Lindl.; the habit and lip in the two are the same and the flowers have some resemblance. The main difference is in the spur and the connective. It is also to be noticed that Watson never published any *Platanthera sparsiflora* but a *Habenaria sparsiflora*, nor any var. *Grayi* of either *Platanthera* or *Habenaria Thurberi*. In the citation of the

place of publication of *P. Ghiesbreghtiana* Rich. et Gal., he has Ann. Sc. Nat. (1845) I. 30, when it should have been III. 3: 30. *Habenaria flagellaris* S. Wats. has never been published.

A work with such numerous and glaring mistakes reflects little credit to the author, and how can it be trusted? He has given the following remarks under his *Platanthera hyperborea*: "Es ist ein gänzlich fruchtloses Bemühen, die unzähligen Formen dieser weitverbreiteten Art unter Diagnosen von besonderen Species zu fixieren. Je tiefer man in die Formenreihe eindringt, desto mehr verschwimmen die bei der Betrachtung einzelner für constant gehaltenen Merkmale. Durch die Liberalität amerikanischer Institute und Botaniker verfügen die europäischen Sammlungen über ein reiches Material, welches die kritische Beurteilung sehr wohl ermöglicht. Alle bisher beschriebenen 'Arten' stellen ihre Berechtigung auf rein habituelle Merkmale, was bei Orchideen stricte zu verwerfen ist."

It is evident that notwithstanding the statement given above the author has not tried very hard to bring the different forms under distinct diagnoses and he has not penetrated very deep into the series of forms when he did not find the broad thin connective of *Habenaria sparsiflora* and *H. breviflora*; perhaps he had seen neither. It is strange if the herbaria of continental Europe should be rich in North American orchids when our own are far from rich and the representation at Kew is very meager. And still if the author had examined the American material when at Kew, he would have been able to correct some of his mistakes. None of the species so far as I know have been merely based on characters in habit, for in all, the spur, the lip, and the stamen have been described more or less completely, and these are the only organs that give any reliable characters. The habit is mostly the same in all and can be used as a diagnostic character only in a few cases.

In discussing *H. brevifolia* Greene, the author remarks: "Der Sammler und Autor der Pflanze vergleicht sie mit *Platanthera* oder nach seiner Schreibart *Habenaria sparsiflora* Wats. Der Vergleich ist nicht glücklich, denn *Pl. sparsiflora* ist eine noch dazu wenig charakteristische Form von *hyperborea*." Prof. Greene's comparison of *H. brevifolia* with *H. sparsiflora* was the only logical one, for the latter was the only known species with the flower-structure of *H. brevifolia*, although this has much larger flowers.

Synopsis of Species

Lip more or less lanceolate, *i. e.*, somewhat dilated near the base.

Flowers greenish or purplish.

Spur not twice as long as the lip. (HYPERBOREAE.)

Spur decidedly clavate, thickened and obtuse at the apex, shorter than the lip.

Petals purplish; spur only one half to two thirds the length of the lip, very saccate.

Lip linear or nearly so, 5-7 mm. long; ovary slightly curved; spike usually elongated. 1. *L. stricta*.

Lip lanceolate, fleshy, 4-5 mm. long; ovary strongly curved; spike usually short. 2. *L. purpurascens*.

Petals greenish; spur almost equalling the lip.

Petals ovate, three fourths as long as the upper sepal; spur very saccate. 3. *L. brachypetala*.

Petals lanceolate, only slightly shorter than the upper sepal; spur less saccate.

Lips less than 5 mm. long, lanceolate.

4. *L. viridiflora*.

Lip over 5 mm. long, ovate-lanceolate.

5. *L. major*.

Spur slender, scarcely thickened at all towards the apex, often acutish, equalling or slightly exceeding the lip.

Plant tall and stout; flowers comparatively large; sepals 4-6 mm. long. 6. *L. media*.

Plant slender; flowers small; sepals 2.5-4 mm. long.

Flowers almost erect in a rather lax spike.

7. *L. Haronensis*.

Flowers lateral in a dense spike. 8. *L. hyperborea*.

Spur about twice as long as the lip. (BEHRINGIANAE.) 9. *L. Behringiana*.

Flowers white or nearly so.

Spur about equalling or only slightly exceeding the lip. (DILATATAE.)

Spur usually shorter than the lip and clavate. 10. *L. borealis*.

Spur equalling or slightly exceeding the lip, slightly or not at all clavate.

Plant over 3 dm. high.

Bracts all longer than the flowers, the lower three times as long; lips about 1 cm. long, the dilated part oval.

11. *L. foliosa*.

Upper bracts shorter than the flowers, the lower at most twice as long; lips 5-7 mm. long, decidedly rhombic at the base.

Petals broadly lanceolate; flowers inodorous or nearly so.

12. *L. dilatata*.

Petals narrowly linear-lanceolate; flower very fragrant.

13. *L. fragrans*.

Plant less than 3 dm. high; petals narrowly linear-lanceolate.

14. *L. leptoceratitis*.

Spur from $\frac{1}{4}$ to $\frac{2}{3}$ longer than the lip. (LEUCOSTACHYAE.)

Spur filiform, mostly acutish.

Plant 3 dm. or less high; spur 7-8 mm. long; lip 5-6 mm.

14. *L. leptoceratitis*.

Plant 5-8 dm. high ; spur 10-14 mm. long ; lip 7-9 mm.

Dilated portion of the lip oval ; spur almost $\frac{2}{3}$ longer than the lip. 15. *L. Thurberi*.

Dilated portion of the lip decidedly rhombic ; spur scarcely $\frac{1}{2}$ longer than the lip. 16. *L. leucostachys*.

Spur clavate at the apex.

Leaves lanceolate or oblanceolate ; stem tall and stout ; lip decidedly rhombic at the base. 16. *L. leucostachys robusta*.

Leaves narrowly linear ; stem slender ; lip not rhombic at the base. 17. *L. graminifolia*.

Lip linear, *i. e.*, not at all dilated at the base.

Spur usually shorter than the lip.

Flowers purplish or greenish ; spur very short and decidedly saccate.

1. *L. stricta*.

Flowers white ; spur almost equalling the lip. (CONVALLARIAEFOLIAE.)

Spur clavate.

18. *L. gracilis*.

Spur filiform.

19. *L. convallariaefolia*.

Spur much exceeding the lip ; flowers greenish or purplish.

Connective narrow ; spur almost twice as long as the lip. (ARIZONICAE.) 20. *L. Arizonica*.

Connective broad.

Leaves elongated, lanceolate or linear ; spur 8-10 mm. long. (SPARSIFLORAE.)

Spike comparatively dense.

21. *L. ensifolia*.

Spike very lax.

Lip about 6 mm. long ; spur about 8 mm., somewhat clavate. 22. *L. laxiflora*.

Lip about 8 mm. long ; spur over 10 mm., filiform.

23. *L. sparsiflora*.

Leaves very short, ovate ; spur almost 1.5 cm. long. (BREVI-FOLIAE.) 24. *L. brevifolia*.

§HYPERBOREAE : Usually small or middle sized species, spike usually dense, except in the first species ; flowers small, greenish or tinged with purple, especially the petals ; spur less than twice as long as the lip ; lip except in *L. stricta* lanceolate, *i. e.*, somewhat dilated at the base but not at all rhombic ; connective narrow and anther-sacs close together.

I. LIMNORCHIS STRICTA (Lindl.) Rydb. Mem. N. Y. Bot. Garden 1 : 105. 1900

Platanthera stricta Lindl. Gen. & Sp. Orchid. Pl. 288. 1835-9 ; *Habenaria gracilis* Wats. Proc. Am. Acad. 11 : 277. 1876 ; *Habenaria hyperborea* Rothrock, Wheeler's Rep. 4 : 265. 1878 ; *Habenaria saccata* Greene, Erythea, 3 : 49. 1895 ; *Habenaria stricta* Ryd. Bull. Torr. Club, 24 : 189. 1897 ; *Platanthera gracilis* Kraenzlin, Orch. Gen. et Spec. 1 : 639. 1899. Not Lindl.

Tall and strict 3-10 dm. high: tubers fusiform, .5-1 cm. in diameter: lower leaves oblanceolate, obtuse, 5-12 cm. long, 15-25 mm. wide: the upper lanceolate, acute: spike usually very long, 1-3 dm., and lax: bracts linear-lanceolate, the lower much longer than the flowers, often 3-4 cm. long: flowers 12-14 mm. long: sepals green, rather thin: the upper ovate, erect, 4-5 mm. long: the lateral ones lanceolate, obtuse, 5-6 mm. long: petals purplish, lanceolate, acute: lip linear, obtuse, 5-7 mm. long, thick, purple: spur one-half to two-thirds as long as the lip, purplish, very saccate, *i. e.*, thickened and round at the apex. (Fig. 1.)



FIG. 1.

The structure of the flowers places this species in the *L. hyperborca* group, although the lip is linear, scarcely at all broadened at the base. This character and the lax spike would place it near *L. laxiflora*, but that is distinguished by the long spur and broad connective. *L. stricta* is common in damp places, swamps, etc., from Alaska to Washington, Wyoming and Montana. It has also been collected in Colorado at Twin Lakes, 1873, *John Wolf*, 965, and Manitou, 1896, *Fred. Clements*.

TYPE: "*America boreali-occidentalis*, *Douglas*."

2. LIMNORCHIS PURPURASCENS Rydb. Bull. Torr. Club, 28: 269.
1901

A rather stout plant, 3-5 dm. high: tubers elongated, fusiform: leaves ovate to lanceolate, acute, 6-10 cm. long, 15-30 cm. wide, dark green: spike dense: bracts lanceolate, the lower exceeding the flowers: these 10-12 mm. long: lateral sepals oblong, linear to lanceolate, obtuse, 4-5 mm. long: the upper broadly ovate, erect, obtuse, tinged with purple: petals slightly shorter, erect, purple, lanceolate: lip broadly linear-lanceolate, obtuse, about 5 mm. long, purplish, thick, slightly dilated at the base: spur one-half to two-thirds as long as the lip, slightly curved and strongly saccate: ovary strongly curved. (Fig. 2.)

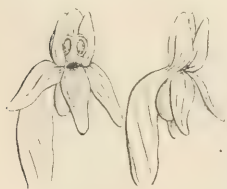


FIG. 2.

This species resembles the preceding in the short spur and purplish flowers, but the habit and form of the lip are more like that of *L. hyperborca*. *L. purpurascens* is a rare plant, growing on

damp wooded hillsides at an altitude of 2700-3000 m. The following specimens belong here :

COLORADO : Iron Mountain, 1900, *Rydberg & Treeland*, 6414 (type in herb. N. Y. Bot. Gard.) ; Georgetown, 1878, *M. E. Jones*, 317 ; Como, South Park, 1895, *C. S. Crandall* ; Mouth of Cheyenne Cañon, 1896, *E. A. Bessey*.

3. *LIMNORCHIS BRACHYPETALA* Rydb. Bull. N. Y. Bot. Garden
2 : 161. 1901.

Stem slender, striate, 4-5-leaved, 1-2 dm. long : tubers elongated fusiform, 7-8 mm. thick : lower leaves oblong, obtuse, 4-6 cm. long, strongly nerved ; the upper lanceolate, acute : spike short, 5 cm. long ; bracts linear-lanceolate, the lower 2-3 times as long as the flowers : flowers greenish or brownish, 8 mm. long : upper sepals about 2 mm. long, nearly orbicular, slightly truncate and indistinctly 3-toothed at the apex ; lateral sepals spreading, oblong, obtuse, nearly 3 mm. long : petals round ovate, acute, slightly over 1 mm. long ; lip very narrow, a little dilated at the base and near the apex, acute : spur clavate, almost saccate, nearly straight, about equalling the lip in length. (Fig. 3.)



FIG. 3.

In habit and flower most like *L. hyperborea*, but with a narrower lip, shorter petals and shorter and thicker spur, which resembles those of the two preceding but is comparatively longer. *L. brachypetala* grows in wet places in Alaska and the Yukon Territory.

YUKON TERRITORY : Bennett City, 1899, *R. S. Williams* (type in herb. N. Y. Bot. Gard.) ; above Fort Selkirk, 1899, *J. B. Tarleton*, 116.

ALASKA : Unalaska, 1891, *J. M. Macoun*, 142.

4. *Limnorchis viridiflora* (Cham.)

Habenaria borealis β *viridiflora* Cham. Linnæa, 3 : 28. 1828 ; *Habenaria hyperborea* S. Wats. Bot. Cal. 2 : 134. 1880 ; in part and subsequent authors ; *Limnorchis hyperborea* Rydb. Mem. N. Y. Bot. Garden, 1 : 104. 1900.

Stem 2-5 dm. high: tubers elongate fusiform, 5-7 mm. thick: lower leaves 5-15 cm. long, 2-3 cm. wide, oblanceolate, obtuse: the upper lanceolate, acute: spike short and dense: bracts linear-lanceolate, the lower slightly exceeding the flowers: flowers 10-12 mm. long, light green: upper sepal broadly ovate, erect, 3-4 mm. long: lateral ones 5-6 mm. long, lanceolate, acutish or obtuse, spreading: petals erect, lanceolate, acute, slightly shorter than the upper sepal: lip lanceolate, obtuse, less than 5 mm. long: spur decidedly clavate, curved, about equalling the lip. (Fig. 4.)



FIG. 4.

This species is closely related to the true *L. hyperborea*, and is its representative in the west. It differs only in the lighter green flower and the thicker and shorter spur. It is also related to *L. borealis* on the other hand, and it is no wonder that Chamisso made it a variety of that species, as it differs only in the green flowers and more saccate spur. Intermediate forms are met with: these are perhaps of hybrid origin. *L. viridiflora* is common in the Rocky Mountain regions and the Cascades. Its range extends from southern Alaska to North Dakota, central Nebraska and Colorado, and is the common plant of the West, known as *Habenaria hyperborea*. Numerous specimens have been examined.

TYPE: "Unalaschka," Chamisso.

5. *Limnorchis major* (Lange)

Platanthera Koenigii Lindley, Gen. & Sp. Orchid. Pl. 286. 1835. Not *Orchis Koenigii* Retz. 1779; *Platanthera dilatata* Torr. Fl. N. Y. 2: 276, in part. 1843; *Habenaria hyperborea* Gray, Man. Ed. 5: 500, in part. 1867; *Platanthera hyperborea* β *major* Lange, Consp. Fl. Groenl. 118. 1880; *Limnorchis hyperborea* Rydb.; Britton, Man. Fl. N. St. 294. 1901, in part.



FIG. 5.

Stem stout, 2-6 dm. high: leaves lanceolate, mostly acute, 5-30 cm. long, 1.5-4 cm. wide: spike dense, 5-15 cm. long: bracts lanceolate, the lower slightly exceeding the flowers: flowers 12-14 mm. long: upper sepal broadly ovate, obtuse, 5 mm. long: the

lateral ones ovate-lanceolate, obtuse, spreading; petals lanceolate, acute, oblique, a little shorter than the sepals; lip 5-6 mm. long, ovate-lanceolate, obtuse; spur almost equalling or somewhat exceeding the lip, distinctly clavate and curved. (Fig. 5.)

This is the most common species in Greenland, but also found on the North American continent. It differs from *L. hyperborea* in the stouter habit, the larger flowers, the broader lip and the clavate spur. It is more common than the specimens cited below seem to indicate, but I have cited here only the specimens in our herbaria, as these are the only ones presently at hand.

GREENLAND: Godhaven, 1878, *L. Kumlcin*; and a specimen by an unknown collector from Hooker's herbarium.

MAINE: Norway, *S. O. Smith*.

WISCONSIN: Milwaukee, *I. A. Lapham*.

NEW YORK: North Yonkers, 1887, *J. F. Poggenburg*; *Torrey*; *A. Gray*.

6. LIMNORCHIS MEDIA Rydb.; Britton, Man. N. St. 294. 1901

Habenaria dilatata Torr. Comp. 318, in part. 1826. Not *Orchis dilatata* Pursh. 1813; *Habenaria hyperborea* Gray, Man. Ed. 5: 500, in part. 1867, and subsequent authors.



FIG. 6.

Stem very stout, 4-8 dm. high: tubers narrowly fusiform, 5-7 mm. thick: leaves lanceolate, acute, 1-2 dm. long: spike long, densely flowered; bracts large, longer than the flowers, with scabrous margins: flowers divaricate, about 15 mm. long: upper sepal ovate, obtuse, about 5 mm. long; lateral ones lanceolate or oblong, 5-6 mm. long: petals green or purplish, lanceolate, acute; lips lanceolate, obtuse, about 6 mm. long; spur filiform, *i. e.*, not at all clavate, curved, slightly longer than the lip. (Fig. 6.)

This is nearest related to the preceding, but still stouter, and differs in the narrower lip and more slender, not clavate spur. In habit it is intermediate between *L. major* and *L. dilatata*, and has been confused with both. The name refers to this fact and not to the size, for it is the largest species of the *hyperborea* group.

CANADA: Quebec, *Mrs. Percival*. (Type in Torrey Herbarium.); Notre Dame chez Lac, 1887, *John Northrop*.

VERMONT: Willoughby, 1892, *H. H. Rusby*.

NEW YORK: *John Torrey*; Silver Bay, Lake George, 1901, *J. F. Kemp*.

WISCONSIN: Milwaukee, 1881, *Dr. Hasse*.

MINNESOTA: Minnehaha Creek, 1890, *E. A. Mearns*, 77.

SOUTH DAKOTA: Harney Peak, 1892, *Rydberg*, 1028 (in part).

7. *LIMNORCHIS HUKONENSIS* (Nutt.) Rydb.; Britton, Man. Fl. N. St. 294. 1901

Orchis Huronensis Nutt. Gen. N. Am. Pl. 2: 189. 1818; *Platanthera dilatata* Beck. Bot. 347, in part. 1833. Not *Orchis dilatata* Pursh. 1814; *Platanthera Huronensis* Lindl. Gen. et Sp. Orchid. Pl. 288. 1835; *Habenaria hyperborea* Gray, Man. Ed. 5: 500, in part; *Platanthera hyperborea* ; var. *dilatata* Kraenzlin, Orch. Gen. & Sp. 640. 1899, in part.

Stem slender, 2-4 dm. high: lower leaves oblanceolate, obtuse; the upper lanceolate, acute, 5-10 cm. long, 1.5-2 cm. wide: spike long, lax; bracts lanceolate, the lower often twice as long as the flowers: flowers light green, almost erect: upper sepal ovate, 2-3 mm. long; lateral ones 2-4 mm. long, oblong to lanceolate, obtuse: petals narrowly lanceolate, slightly shorter than the sepals, oblique; lip linear-lanceolate, 3-4 mm. long; spur filiform, not clavate, strongly curved and slightly longer than the lip. (Fig. 7.)



FIG. 7.

This species is nearest related to *L. hyperborea*, and distinguished by the erect flowers, the narrower lip and the longer pod. It is also usually taller with a laxer spike.

TYPE: "In wet places on the islands of Lake Huron and Michigan."

CANADA: Quebec, *Mrs. Percival*.

VERMONT: Monkton, 1879, *C. G. Pringle*.

MASSACHUSETTS: Shelbourne, 1889, *Geo. F. Taylor*.

CONNECTICUT: Canaan, 1866, *W. H. Leggett*.

NEW YORK: Utica, 1833, *Dr. Gray*; Albany, *L. C. Beck*; Jamesville, 1890, *L. M. Underwood*; Silver Bay, Lake George, 1901, *J. F. Kemp*; Catskills, 1887, *G. Rampsberger*.

MICHIGAN: Long Lake, 1890, *Beardsley & Kofoid*.

MINNESOTA: Chisago Lake, 1892, *B. C. Taylor*.

WISCONSIN: Madison, *S. H. Watson*.

8. *LIMNORCHIS HYPERBOREA* (L.) Rydb.; Britton, Man. Fl. N. St.
294, in part. 1901

Orchis hyperborea L. Mant. 121. 1767; *Habenaria hyperborea*
R. Br. Hort. Kew. Ed. 2: 5: 193. 1813; *Platanthera hyperborea*
Lindl. Gen. & Sp. Orchid. Pl. 287. 1835.



FIG. 8.

Low and slender, 1.5–4 dm. high: tubers almost fleshy-fibrous, slightly thicker than the roots: lower leaves oblanceolate, obtuse, 5–10 cm. long, 1–2 cm. broad; the upper lanceolate, acute: spike rather dense; bracts linear-lanceolate, the lower slightly longer than the flowers: flowers light green, 8–12 mm. long: upper sepal broadly ovate, obtuse, 3–4 mm. long; lateral ones lanceolate: petals lanceolate, slightly shorter than the sepals; lip lanceolate, obtuse, nearly 5 mm. long; spur filiform, strongly curved and a little exceeding the lip. (Fig. 8.)

In habit *L. viridiflora* and this species are much alike and the former would have been merged in the latter, if all the western specimens (*i. e.*, *L. viridiflora*) seen, had not had more or less clavate spur, a character not seen in Icelandic, Greenlandic and eastern specimens.

TYPE: "Islandia, *König*."

ICELAND: Gardas, 1888, *Prof. & Mrs. Sprague Smith*.

CANADA: Big Swamp, 1866, *J. Macoun*.

NEW BRUNSWICK: Kennebecosis, 1871, *J. Fowler*.

VERMONT: Willoughby, 1892, *H. H. Rusby*.

NEW YORK: Kirkville, Onondaga county, 1891, *L. M. Underwood*, 3155.

§ BEHRINGIANAE: Low plants, 1–1.5 dm. high: spike short and dense: flowers greenish-purple; lip oblong-lanceolate; spur fully twice as long as the lip; connective narrow.

9. *Limnorchis Behringiana* sp. nov.

Stem low, 1–1.5 dm. high, about 3-leaved: tubers elongated fusiform, about 5 mm. thick: lower leaf ovate-lanceolate, about 5 cm. long and 1.5–2 cm. wide; the upper lanceolate and smaller: spike dense, 3–4 cm. long; bracts linear-lanceolate, the lower about

twice as long as the flowers : flowers purplish, about 12 mm. long : upper sepal ovate, obtuse, 4-5 mm. long ; the lateral ones oblong : petals equalling the sepals, broadly lanceolate ; lip about 5 mm. long ; spur fully 10 mm. long, filiform. (Fig. 9.)

This species is not closely related to any of the other species. The type specimens were labelled *Habenaria gracilis* Wats. With this, i. e., *L. stricta* it has scarcely anything common except the color of the flowers and such characters as are found in all species of *Limnorchis*. *L. Behringiana* has not been found in North America but I include it in here, as it would likely be found in Alaska, as *L. convallariaefolia* from the same region has been.

ASIA : Behring Island, 1891, *British Behring Sea Commission*, 143 (type in herb. Columbia Univ.).

§ DILATATAE : Plants usually middle sized : flowers white or in the first species yellowish-white ; lip lanceolate, more or less distinctly rhombic dilated near the base ; spur equalling or slightly longer than the tip ; connective narrow.

10. *Limnorchis borealis* (Cham.)

Habenaria borealis Cham. Linnaea, 3 : 28. 1828 ; *Platanthera dilatata* Lindl. Gen. and Sp. Orchid. Pl. 287 ; in part. 1835 ; *Habenaria dilatata* Coult. Man. Rocky Mts. 342. 1885 ; *Habenaria dilatatifomis* Rydb. Bull. Torr. Club, 24 : 189. 1897 ; *Platanthera hyperborea* γ var. *dilatata* Kraenzlin, Orch. Gen. et Sp. 640. 1899, in part ; *Limnorchis dilatatifomis* Rydb. Mem. N. Y. Bot. Garden, 1 : 105. 1900.



FIG. 10.

Tall and leafy, 4-8 dm. high : tubers elongated fusiform, 5-8 mm. thick : lowest leaves oblanceolate and obtuse ; the rest lanceolate, acute, 5-15 cm. long, 1.5-2.5 cm. wide : spike often rather dense, 1-2 dm. long ; bracts lanceolate, the lower often much exceeding the flowers : flowers 10-14 mm. long, white or sometimes yellowish or greenish white : upper sepal ovate, obtuse, 4-5 mm. long ; the lateral ones oblong-

lanceolate, spreading: petals lanceolate, slightly shorter than the sepals; lips rhombic-lanceolate, obtuse, about 5 mm. long; spur usually shorter than the lip, and more or less clavate. (Fig. 10.)

This species represents *L. dilatata* in the Rocky Mountain region, but differs in the smaller flowers and shorter, more clavate spur. It also approaches *L. viridiflora*, from which it differs in the whiter flowers and more rhomboid lip. Where growing together, intermediate forms are often found, perhaps of hybrid origin. *L. borealis* is common from Alaska to Washington and Colorado.

TYPE: "Unalaschka," Chamisso.

11. *Limnorchis foliosa* sp. nov.

Stem stout and very leafy, about 3 dm. high: leaves linear-lanceolate, attenuate, 1-1.5 dm. long: spike short and dense, less than 1 dm. long; bracts linear-lanceolate, attenuate, about three times as long as the flowers: these about 15 mm. long, white: upper sepal broadly linear, obtuse, about 6 mm. long; lateral ones narrowly lanceolate, about 9 mm.: petals narrowly linear-lanceolate, attenuate; lip about 10 mm. with an oval base and an almost linear lower half, obtuse; spur about the length of the lip, filiform, not at all clavate. (Fig. 11.)



FIG. 11.

This species has the habit of *Perularia flava* and *Cocloglossum bracteatum*, but the flower is of the typical *Limnorchis* type and places it nearest to *L. dilatata*. The flowers, however, are larger and the lip less rhomboid.

ALASKA: Nagai, 1871-2, *M. W. Harrington* (Dall's Exploration; type in the Columbia herb.).

12. *LIMNORCHIS DILATATA* (Pursh) Rydb.; Britton, Man. Fl. N. States, 294. 1901

Orchis dilatata Pursh, Fl. Am. Sept. 588. 1814; *Habenaria dilatata* Hook. Exot. Fl. pl. 95. 1825; *Platanthera dilatata* Lindl.; Beck. Bot. N. & M. St. 347, in part. 1833; *Platanthera hyper-*

borca 7 var. *dilatata* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899.

Stem slender, tall, leafy, 3-6 dm. high : leaves lanceolate, 7-20 cm. long, the lower obtuse, the upper acute : spike 5-25 cm. long, usually rather lax ; bracts linear-lanceolate, the lower twice as long as the flowers : flowers white, 15-18 mm. long : upper sepal ovate, obtuse, about 6 mm. long, the lateral ones lanceolate, acutish : petals acute, lanceolate ; lip lanceolate with a rhomboid base, about 7 mm. long ; spur longer than the lip, filiform, scarcely at all clavate. (Fig. 12.)



FIG. 12.

L. dilatata is common from Newfoundland to Saskatchewan, south to New York and Nebraska.

TYPE : " In Labrador. Colmaster, v. s. in Herb. Dickson."

***Limnorchis dilatata linearifolia* var. nov.**

Stem slender ; leaves linear, attenuate, 5-10 cm. long, 5-7 mm. wide.

Very different from the species in general habit, but the flowers are exactly the same, and intermediate forms are not lacking.

NEW YORK : Bridgewater, *Dr. Gray* (type in herb. Torrey).

MICHIGAN : Portage of Kee-wana-wa, *Dr. Peters*.

13. **LIMNORCHIS FRAGRANS** Rydb.; Britton, Man. Fl. N. States, 294. 1901

Stem slender, 2-3 dm. high : tubers narrowly fusiform, about 5 mm. thick : leaves linear, about 1 dm. long and 8-10 mm. wide, acute : spike slender, lax ; bracts lanceolate, acuminate ; the lower longer than the flowers : flowers pure white, very fragrant : upper sepal ovate-lanceolate, obtuse ; the lateral ones linear-lanceolate, acutish, strongly veined : petals narrowly linear-lanceolate, equalling the sepals ; lip lanceolate with an ovate-rhomboid base, about 5 mm. long ; spur filiform, not at all clavate, curved, slightly exceeding lip. (Fig. 13.)



FIG. 13.

Closely resembling the variety of preceding species, it is distinguished by the narrow petals and sepals and by the fragrance.

The two sheets of the original collection in the Columbia Herbarium are the only ones seen.

VERMONT : Willoughby Mountain, 1892, *H. H. Rusby* (type in herb. Columbia Univ.).

14. *LIMNORCHIS LEPTOCERATITIS* Rydb. Bull. N. Y. Bot. Garden, 2 : 162. 1901

Stem slender, 2-4 dm. high : tubers slender, slightly thicker than the fleshy fibrous roots : lower leaves oblong, obtuse, 4-8 cm. long, 1-1.5 cm. wide, the upper linear-lanceolate, acute : spike short, less than 1 dm. long ; bracts linear-lanceolate, the lower somewhat longer than the white flowers : sepals 3-4 mm. long, lanceolate : petals linear or narrowly linear-lanceolate, about equalling the sepals ; lip lanceolate, somewhat rhombic, dilated at the base ; spur very slender, filiform, strongly curved forward, a little exceeding the lip. (Fig. 14.)



FIG. 14.

This is nearest related to the eastern *L. dilatata* and *L. fragrans*, but differs in the smaller size, smaller flowers and shorter leaves. In habit it resembles most a depauperate *L. borealis*, but the spur is different.

YUKON TERRITORY : Bennett City, 1899, *R. S. Williams* (type in herb. N. Y. Bot. Gard.).

ALASKA : Unalaska, 1891, *J. M. Macoun* ; southern Alaska, 1883, *J. Albert Rudkin*.

BRITISH COLUMBIA : Tulameen River, 1900, *J. F. Kemp*.

§ *LEUCOSTACHYAE* : Tall and stout plants : flowers pure white or slightly greenish in *L. Thurberi* ; lip lanceolate with a more or less rhombic or oval dilatation near the base ; spur more than $\frac{1}{4}$ longer than the tip ; connective narrow : spike long and dense.

15. *Limnorchis Thurberi* (A. Gray) Rydb.

Habenaria Thurberi A. Gray, Proc. Am. Acad. 7 : 389. 1868 ; *Habenaria leucostachys* S. Wats. Bot. Cal. 2 : 134, in part. 1880 ; Coville, Cont. U. S. Nat. Herb. 4 : 201. 1893 ; *Platanthera hyperborea* δ var. *leucostachys* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899.

Stem stout and leafy, 4-6 dm. high: tubers elongated fusiform, 6-7 mm. in diameter: leaves lanceolate to linear-lanceolate, 1-2 dm. long, 1.5-3 cm. wide, acute: spike long and dense; bracts linear-lanceolate, attenuate, about equalling the flowers: these dull white, 16-20 mm. long: upper sepal ovate, obtusish; the lateral ones lanceolate, acute: petals lanceolate, about equalling the sepals; lip 7-8 mm. long, lanceolate, obtuse, the dilated portion ovate; spur filiform, curved, about $\frac{2}{3}$ longer than the lip.



FIG. 15.

This has been merged into *L. leucostachys*, which it resembles in habit, but the spike is denser, the flowers are dull or greenish white, and the form of the lip is different.

TYPE: "Arizona, Thurber (925)."

NEW MEXICO: 1851-52, *C. Wright*, 1900.

CALIFORNIA: *Thomas Bridges*, 356; Mammoth, 1891, *Coville & Funston*, 1822; Miner's Ditch, Nevada county, 1867, *N. J. Davis*, 37; Canoe Creek, *J. S. Newberry*; Nevada, 1893, *Michener & Bioletti*; Sisson, 1897, *H. E. Brown*, 320; Marin county, 1873, *Edwards*; Bernardino Mts., 1882, *S. B. & W. F. Parish*, 1521; Fresno county, 1900, *Hall & Chandler*, 150.

16. *LIMNORCHIS LEUCOSTACHYS* (Lindl.) Rydb. Mem. N. Y. Bot. Garden, 1: 106. 1900.

Platanthera leucostachys Lindl. Gen. & Sp. Orchid. Pl. 288; *Habenaria leucostachys* S. Wats. Bot. Cal. 2: 134. 1880; *Platanthera hyperborea* δ var. *leucostachys* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899.

Stem stout and tall, 6-10 dm. high: lower leaves oblanceolate, 1-2 dm. long, 1.5-3 cm. wide; the upper lanceolate, acute: spike 1-3 dm. long, rarely very dense; bracts linear-lanceolate, the lower exceeding the flower: these purely white, 15-20 mm. long: upper sepal ovate, obtuse, about 5 mm. long; lateral ones lanceolate, acute, 7-8 mm. long: petals lanceolate, attenuate, a little shorter than the upper sepal; lip lanceolate with a decidedly rhombic base, about 8 mm. long; spur filiform, scarcely clavate,

acutish, about half longer than the lip, less than 1 mm. thick. (Fig. 16.)



FIG. 16.

Lindley describes this as having the lip half as long as the spur, but I have not seen any with so long a spur, not even in Douglas' specimens at Kew.

TYPE: "In ora occidentali Americae septentrionalis, Douglas (hab. s. sp. comm. Soc. Hort.)."

ALASKA: Ankow River, 1892, F. Funston, 52.

WASHINGTON: Snoqualmie, 1892, M. Parker; Wallawalla to Kuskuski, 1838-42, Wilkes Exp., 526.

IDAHO: 1892, Isabel Mulford; Priest Lake, 1900, D. T. MacDougal, 7 and 178.

UTAH: 1871, Palmer, 461.

NEVADA: E. Humboldt Mountains, 1868, S. Watson, 1154.

CALIFORNIA: Sierra county, 1874, Linnon; Plumas county, 1881, Mrs. Austin; Yosemite Valley, 1866, Bolander, 4936.

***Limnorchis leucostachys robusta* var. nov.**

Very stout and tall, 4-10 dm. high, leafy: spike long and dense, 1-3 dm. long: spur usually clavate, over 1 mm. thick, obtuse, about one-third longer than the lip. (Fig. 17.)

This may be distinct from *L. leucostachys* but the only characters distinguishing it from the type is the thicker spur and the denser spike. More field work is needed in order to settle its relationship to *L. leucostachys*. The following specimens are in our herbaria:



FIG. 17.

OREGON: 1871, Elihu Hall, 505.

WASHINGTON: 1889, R. S. Vasey, 77 (type in herb. N. Y. Bot. Gard.); Chevalis River, 1897, Frank H. Lamb, 1199a; Olympia, 1898, A. A. & E. G. Heller, 4046; Falcon Valley, 1893, W. H. Saksdorf, 1356; Upper Valley of the Nesqually, 1894, O. D. Allen; Yakima Region, 1883, F. Tweedy; Palace Camp,

1883, *Mrs. Bailey Willis*; Seattle, 1890, *C. V. Piper*; Cascade Mts., 1882, *Brandegee*, 480.

BRITISH COLUMBIA: Vancouver Island, 1887, *John Macoun*; Tulameen River, 1900, *Prof. J. F. Kemp*.

IDAHO: Valley of Clearwater River, 1892, *Sandberg*, *MacDougal & Heller*, 288.

17. *Limnorchis graminifolia*

Platanthera graminca Lindley, Gen. & Sp. Orchid. Pl. 289. 1835; not *Habenaria graminca* Spreng. Syst. 3: 690. 1826; nor *P. graminca* Lindley, l. c. 292; *Platanthera hyperborea* ? var. *dilatata* Kraenzlin, Orch. Gen. et Sp. 640, in part, 1890.

Very slender, 3-4 dm. high: leaves narrowly linear, 5-10 cm. long, 3-4 mm. wide: spike short; bracts lanceolate, shorter than the flowers: these white, 12-15 mm. long: upper sepal ovate, 4 mm. long, the lateral ones lanceolate: petals narrowly lanceolate, slightly shorter than the upper sepal; lip lanceolate, obtuse, dilated near the base, but not rhombic; spur one-third to one-half longer than the lip, clavate towards the apex, acute. (Fig. 18.)



FIG. 18.

This plant is nearest related to *L. leucostachys*, but differs in the slender habit, narrow leaves and the form of the lip. The type is in Lindley's herbarium, where I saw it. The specimens from Lower Canada I cannot distinguish from the Alaskan specimens, although the occurrence of the species on the east coast is exceedingly remarkable.

TYPE: "In ora occidentali Americae septentrionalis, *Menzies* (hab. s. sp. comm. col. *Menzies*)."

ALASKA: Douglas Island, 1891, *Grace E. Cooley*; Gorman's Lake, 1895, *M. W. Gorman*, 74.

CANADA: Mouth of Riviere du Loup, *Wm. Canby*.

§ CONVALLARIAEFOLIAE: Slender plants about 3 dm. high: spike short and rather lax: flowers white; lip linear, not at all dilated at the base; spur about equalling the lip; connective narrow.

18. *Limnorchis gracilis* (Lindl.).

Platanthera gracilis Lindley, Gen. & Sp. Orchid. Pl. 288. 1835.

Slender, about 3 dm. high: leaves oblong to lanceolate, 5–10 cm. long, 1–1.5 cm. wide, the lower obtuse, the upper acute: spike slender and lax, about 1 dm. long; bracts lanceolate the lower slightly exceeding the flowers: these white, 10–12 mm. long: upper sepal broadly oval, about 4 mm. long, the lateral ones linear-lanceolate, acute: petals linear-lanceolate; lip linear, obtuse, 6–7 mm long; spur clavate, only slightly curved, a little shorter than the lip. (Fig. 19.)



FIG. 19.

This resembles *L. stricta* in the linear lip and the lax spike, but has white flowers and slender spur. Watson confused the two and following him, most authors have used the name *Habenaria gracilis* for *L. stricta*. No one who has seen Lindley's type could confuse the two.

TYPE: "In ora occidentali Americae septentrionalis, Menzies; Observatory inlet, *Herb. Hooker* (*hab. s. sp. comm. ccl. Menzies*)."

ALASKA: Back Bay, 1895, *M. W. Gorman*, 52 (in Columbia Herbarium); Sitka, 1891, *W. G. Wright* (1559) (?).

SUBARCTIC AMERICA: 1861–2, *I. S. Onion*.

19. *Limnorchis convallariaefolia* (Lindl.)

Platanthera convallariaefolia Lindl. Gen. & Sp. Orchid. Pl. 287. 1835; *Platanthera hyperborea* β , var. *convallariaefolia* Kraenzlin, Orch. Gen. et Sp. 640. 1899.

Stem slender, about 3 dm. high: leaves oblong-lanceolate or oblanceolate, 4–8 cm. long, 1–2 cm. wide, the lower obtuse, the upper acute: spike short, less than 1 dm. long; bracts lanceolate or linear-lanceolate, equalling or the lower exceeding the whitish flowers: upper sepal almost orbicular or broadly ovate, 3–4 mm. long; lateral ones lanceolate, obtuse: petals lanceolate, acute; lip linear, about 6 mm. long, obtuse; spur filiform, curved, almost equalling the lip. (Fig. 20.)



FIG. 20.

This is closely related to *L. gracilis*, and differs scarcely in any respect except that the flowers are smaller and the spur is longer and more slender. It was described from specimens collected by

Fischer in Kamtchatka. The type is in Lindley's herbarium and a cotype in Torrey's. The Unalaska specimen also collected by Fischer, I cannot distinguish from the Asiatic.

TYPE: "In Kamtchatka, Fischer (*hab. s. sp. comm. col. Prescott*)."

ASIA: Kamtchatka, Fischer, *ex. herb. Lindley*.

ALASKA: Unalashca, Fischer.

§ ARIZONICAE: Rather stout, 5-7 dm. high: spike long and lax: flowers light greenish; lip linear, not at all dilated at the base: spur filiform, almost twice as long as the lip; connective narrow.

20. *Limnorchis Arizona* sp. nov.

Stem tall, leafy: lower leaves oblong, about 5 cm. long, obtuse, the middle and upper ones linear, the former 2-3 dm. long, 2-3 cm. wide: spike slender, lax, many-flowered 1.5-3 cm. long; bracts linear-lanceolate, the lower slightly longer than the flowers: these 12-15 mm. long, greenish or purplish: upper sepal broadly ovate, 3-4 mm. long; lateral ones ovate-lanceolate: petals lanceolate, acute, slightly shorter than the upper sepal, 4-5 mm. long. (Fig. 21.)



FIG. 21.

This species resembles somewhat both *L. stricta* and *L. sparsiflora*. From the former it is easily distinguished by the long slender spur and from the latter by the many-flowered spikes, smaller flowers and narrow connective. It grows in rich cañons of Arizona.

ARIZONA: 1891, *Nealley* (type in herb. N. Y. Bot. Gard.); Santa Rita Mts., 1881, *C. G. Pringle*; Ft. Huachuca, 1893, *T. E. Wilcox*; Weber Creek, 1887, *E. A. Mearns*, 133.

§ SPARSIFLORAE: Plant slender, light green: spike elongated: flowers greenish with strongly reflexed sepals; lip linear; spur slender, much longer than the lip; connective very broad: leaves normal.

21. *Limnorchis ensifolia* sp. nov.

Platanthera hyperborea ò var. *leucostachys* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899; not *P. leucostachys* Lindl.

Stem strict, 3-4 dm. high, light colored, few leaved: leaves linear-lanceolate, attenuate, slightly falcate, 1-1.5 dm. long, 1-1.5 cm. wide: spike short and not very lax; bracts lanceolate,

acuminate, light green, about equalling the flowers: these greenish, about 15 mm. long: upper sepal broadly ovate, about 5 mm. long; lateral sepals about 7 mm. long, oblong-lanceolate: petals narrowly lanceolate, acute; lip linear, about 8 mm. long, thick; spur filiform, about 1 cm. long. (Fig. 22.)

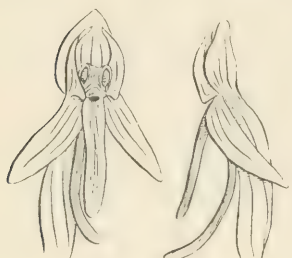


FIG. 22.

This is nearest related to *L. sparsiflora*, but the spike is shorter and denser, the upper sepals and petals larger and the bracts shorter and broader, and light colored. The type was growing at an altitude of about 2600 mm.

ARIZONA: Mt. Humphrey, 1897, *R. E. Kunze* (type in herb. N. Y. Bot. Gard.); Willow Springs, 1874, *Rothrock*, 269.

UTAH: "Central Utah," 1875, *C. C. Parry*, 89; Rock Creek, 1877, *Dr. E. Palmer*, 460 (in part).

NEW MEXICO: Silver City, 1880, *E. L. Greene*.*

22. *Limnorchis laxiflora* sp. nov.

Stem slender, 4–6 dm. high: lower leaves oblanceolate, obtuse, 8–10 cm. long, 1–1.5 cm. wide; the upper linear-lanceolate, acute: spike very slender and lax, 1–2 dm. long, few-flowered; bracts linear-lanceolate, usually equalling or shorter than the flowers: these greenish, 10–12 mm. long: upper sepals broadly obovate, obtuse, about 4 mm. long; lateral ones broadly lanceolate, acutish: petals almost equalling the upper sepal, lanceolate; lip linear, obtuse, about 6 mm. long; spur about 8 mm. long, slightly clavate, a little longer than the lip. (Fig. 23.)



FIG. 23.

This is closely related to and has been mistaken for *L. sparsiflora*, which, however, has larger flowers, longer spur, not at all clavate, longer bracts and more slender stem.

OREGON: Coast Mountains, 1884, *Thomas Howell* (type in herb. Columbia College); Interior of Oregon, 1838–42, *Wilkes Expedition*; 1871, *Elihu Hall*, 504.

UTAH: Rock Creek, 1877, *Dr. E. Palmer* (460 in part).

* This is labelled *Habenaria flagellaris* Wats.

COLORADO: Uncompahgne Mountains near Los Pinos, 1878, *Wm. F. Flint*.

23. ***Limnorchis sparsiflora*** (S. Wats.) Rydb.

Habenaria sparsiflora S. Wats. Proc. Am. Acad. **12**: 276. 1877; *Platanthera hyperborea* ♂ var. *leucostachys* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899.

Stem tall and slender, 4–6 dm. high: lower leaves oblanceolate, obtuse, 1–2 dm. long, 1.5–3.5 cm. wide; the upper lanceolate, acute: spike long, slender and lax, 2–3 dm. long; bracts linear-lanceolate, usually exceeding the flowers: these light green, very delicate, about 15 mm. long: upper sepal broadly ovate, 4–5 mm. long; the lateral ones lanceolate, acute, about 6 mm. long: petals narrowly lanceolate, acute; lip linear, about 8 mm. long, obtuse; spur filiform, about 1 cm. long. (Fig. 24.)



FIG. 24.

This is characterized by the long, slender, lax spike, delicate green flowers and long bracts. The type was collected by Bolander, near Mariposa Grove, California.

OREGON: Kerbyville, 1884, *T. Howell*.

CALIFORNIA: Donner Lake, 1865, *J. Torrey*, 511; Pine Ridge, Fresno county, 1900, *Hall & Chandler*, 139; Truckee River, 1893, *C. F. Sonne*; Mt. Dyer, 1879, *R. M. Austin*; Sierra county, 1874, *Lemmon*.

NEW MEXICO: 1881, Mongollon Mountains, *H. H. Rusby*.

§ BREVIFOLIAE: Like the SPARSIFLORAE, but leaves very short, much reduced: flowers nearly twice as large.

24. ***Limnorchis brevifolia*** (Greene) Rydb.

Habenaria brevifolia Greene; Coulter, Bot. Gaz. **6**: 218. 1881; *Platanthera hyperborea* ♂ var. *leucostachys* Kraenzlin, Orch. Gen. et Sp. 640, in part. 1899.

Stem strict, leafy, 3–6 dm. high: leaf-blades ovate, 2–4 cm. long and about 1 cm. wide, acute: spike elongated, 1–2 dm. long; bracts similar to the leaves but smaller, about equalling the flowers: these green, 2–2.5 cm. long: upper sepal ovate, about 5 mm. long; lateral sepals linear, acute, about 8 mm. long: petals



FIG. 25.

linear-lanceolate, acute, a little shorter than the upper sepal; lip linear, obtuse, about 10 mm. long; spur filiform, about 15 mm. long. (Fig. 25.)

This is characterized by its large flowers and reduced leaves.

TYPE: "On dry southward slopes of the Pinos Altos Mountains, New Mexico, in 1880."

NEW MEXICO: White Mountains, 1897, *E. O. Wooton*, 544; Pinas Altos Mountains, *E. L. Greenc.*

MEXICO: State of Chihuahua, Sierre Madre, 1887, *C. G. Pringle*, 1374.

PIPERIA Rydb. Bull. Torr. Club, 28: 269. 1901

Somewhat leafy-stemmed plants, but the leaves are usually near the base and withering at or before the anthesis, the stem-leaves being reduced and bract-like: tubers spherical or rounded ellipsoid; flowers greenish or white; sepals and petals 1-nerved or very obscurely 3-nerved; the upper sepal ovate or lanceolate, erect; the lateral ones spreading, linear to lanceolate, their bases united with the claw of the lip; upper petals free, lanceolate or linear-lanceolate, oblique, but not cordate; the blade of the lip linear-lanceolate to ovate, obtuse, truncate or hastate at the base, concave but with a longitudinal low ridge in the middle produced by the undulation of the lip; the claw, if it can be called so, united with the bases of the lower sepals, bordered with an erect margin which connects the lip with the column; anther cells unusually large for the size of the flower, parallel, opening nearly laterally; stigma a small beak in the angle between the anther-cells; ovary sessile, ellipsoid in fruit.

The principal differences between *Limnorchis* and *Piperia* are the following:

LIMNORCHIS

Tubers elongated fusiform, root-like.

Stem leafy; leaves remaining until fruit is set.

PIPERIA

Tubers rounded.

Stem leafy at the base; leaves withering at or before anthesis.

LIMNORCHIS

PIPERIA

Sepals 3-7-nerved; petals distinctly 3-nerved, without gibbosities.

Lateral sepals free.

Lip flat or concave, without median ridge, not truncate at the base, free.

Anther-cells opening in front.

Petals and sepals 1-nerved or obscurely 3-nerved, with small gibbosities at their bases.

Lateral sepals with their bases adnate to the claw of the lip.

Lip with a more or less distinct median ridge; blade truncate or hastate at the base; a margin connecting the claw with the column.

Anther-cells opening laterally.

The first species of *Piperia* was originally described as *Spiranthes Unalaschensis* Sprengel * and generally known as *Habenaria Unalaschensis* Wats. In the Kew Index this species is referred to *Herminium congestum*, a plant from northern India. We have no specimen of the latter, but the identity is so unlikely that I did not think of making a comparison when I visited Kew last summer. *P. Unalaschensis* is no *Herminium*, however, for that genus is distinguished by the total absence of a spur besides by different structures of the column. Kraenzlin recognizes both *Platanthera Unalaschensis* and *P. foetida*. It is true that no one seems to know exactly what *Spiranthes Unalaschensis* Sprengel really was, but I know of no plant except the present species, which agrees with Sprengel's short description. Kraenzlin placed *P. Unalaschensis* among the scapose species and *P. foetida* among the foliose, but in the description he characterizes the latter as having the leaves near the base. I cannot find any character on which to base a segregation of two species. The publication of *Platanthera foetida* Geyer, is generally given as Hook. Journ. Bot. 7: 376. 1855; but there is no description, only the name and references to the locality where it was collected. The first real publication seems to have been in King's Report, where Watson gives it as a synonym under *Habenaria foetida* there described. *Gymnadenia longispica* Durand † has been referred to this species, but this must be a mis-

* Syst. 3: 708. 1826.

† Pl. Pratten, 101. 1855.

take as that species was described as having a spur longer than the ovary, which is not the case with *P. Unalaschensis*.

The second species of *Piperia* was first described as *Platanthera elegans* Lindl.* from specimens collected by Douglas in north-western America. It seems from the description as if more than one species had been included therein as for instance "*caule squamis parvis ramentaceis, spica longa densa cylindracea.*" Although this species has scale-like stem leaves, they are not by far so conspicuous as in the species that Bolander took for *H. elegans* and that the spike is described as dense does not very well fit this species. Not having any authentic specimen I naturally thought that the name *Platanthera elegans* Lindley belonged to the species named *Habenaria elegans* by Bolander or else the one that I have described here as *Piperia multiflora*. I therefore described the lax-flowered species under the name *P. elongata*. At Kew last summer, I found only one specimen collected by Douglas and this I refer to my *P. elongata* although its spike is more dense than in my type, but not denser than some specimens of the same species in our herbaria. It is, therefore, best to pass my *P. elongata* into synonymy for the present.

With regard to *Habenaria elegans* Bolander it must be stated that it was not properly published before it appeared in the Botany of California, for in Bolander's Catalogue of the Flora of San Francisco it is a *nomen nudum*, without description or synonyms. What Bolander's plant was is not unknown, for there is one specimen in the Torrey herbarium collected and named by Bolander. This can scarcely be distinguished from *Habenaria Michxli* Greene,† although it has a longer, less crowded spike.

A further study has revealed that several other species than the ones enumerated in the place of publication of *Piperia*, must be included in that genus, viz., *Habenaria Michxli* Greene, and *Gymnadenia longispica*, both mentioned above, *Habenaria Cooperi* Wats.‡ and *Habenaria maritima* Greene.§ Concerning *H. Cooperi* Wats. it may be remarked that it was placed by Watson in that

* Gen. & Spec. Orchid. Pl. 285. 1835.

† Man. Bay Reg. Bot. 306. 1894.

‡ Proc. Am. Acad. 12 : 276. 1876.

§ Pittonia, 2 : 298. 1892.

section of *Habenaria* which now constitutes *Limnorchis*, but his description of the flower is the best hitherto given of any species of *Piperia*.

Synopsis of Species

Spur less than twice as long as the lip.

Stem leafy only at the base; lip oblong; spur slender, slightly exceeding the lip. 1. *P. Unalaschensis*.

Stem more or less leafy; lip ovate.

Spur slightly exceeding the lip, very saccate. 2. *P. Cooperi*.

Spur nearly twice as long as the lip, only slightly clavate.

3. *P. lancifolia*.

Spur 2-3 times as long as the lip, filiform.

Lip linear to lanceolate.

Spike very lax; lip 4-5 mm. long; spur about 8-10 mm.

4. *P. leptopetala*.

Spike dense; lip about 6 mm. long; spur 15-18 mm. long.

5. *P. multiflora*.

Lip ovate or ovate-lanceolate.

Spike elongated, lax; leaves withering at anthesis.

Bracts linear-lanceolate; stem leafy only at the base.

6. *P. coccinea*.

Bracts ovate-lanceolate; stem usually leafy.

7. *P. longispica*.

Spike short and very dense; flowers crowded; leaves withering before anthesis.

Petals and sepals about 4 mm. long; petals purplish or greenish.

8. *P. Michaeli*.

Petals and sepals about 5 mm. long; petals white. 9. *P. maritima*.

1. *PIPERIA UNALASCHENSIS* (Spreng.) Rydb. Bull. Torr. Club, 28 : 270. 1901

Spiranthes Unalaschensis Spreng. Syst. 3 : 708. 1826; *Habenaria Schischmareffiana* Cham. Linnaea, 3 : 29. 1828; *Herminium Unalaschkense* Reichenb. Fl. Germ. 13 : 107. pl. 65; *Platanthera Schischmareffiana* Lindl. Gen. & Sp. Orchid. 286. 1835; *Habenaria foetida* S. Wats. Bot. King's Exped. 5 : 341. 1871; *Platanthera foetida* Geyer. as a synonym under the preceding; *Habenaria Unalaschensis* Wats. Proc. Am. Acad. 12 : 277. 1877; *Montolivaea Unalaschensis* Rydb. Mem. N. Y. Bot. Gard. 1 : 107. 1900.

Stem strict, slender, 3-5 dm. high, leafy only near the base; basal leaves oblanceolate, obtuse or acutish, 1-1.5 dm. long, .8-3 cm. wide, withering at anthesis or soon after; stem leaves bract-like, linear-lanceolate to lanceolate, attenuate, .5-1 cm. long; spike long and lax, 1-3 dm. long; bracts lanceolate to ovate-lanceolate,

one-half to two-thirds as long as the flowers : these greenish, distinctly in spirals, 8–10 mm. long : petals and sepals 2–4 mm. long, upper sepal ovate, acutish ; lateral ones oblong-lanceolate, obtusish : petals purplish green, somewhat fleshy, lanceolate, oblique at the base ; lip oblong, obtuse, slightly hastately lobed near the base ; spur filiform or slightly clavate, a little exceeding the lip but shorter than the ovary. (Fig. 26.)



FIG. 26.

P. Unalaschensis is common from southern Alaska and Alberta to California and Colorado, and grows in damp woods.

TYPE : "*Ins. Aleut.*"

The following locality is remarkable, being far out of the supposed range :

QUEBEC : Jupiter River, Anticosti, 1883, *John Macoun*.

2. *Piperia Cooperi* (S. Wats.)

Habenaria Cooperi S. Wats. Proc. Am. Acad. **12** : 276. 1876.

Tall and strict, 3–10 dm. high, leafy below : basal leaves oblong lanceolate, acute, about 1 dm. long ; lower stem leaves lanceolate, attenuate, 10–15 cm. long ; the upper reduced and bract-like, lanceolate, 1–2 cm. long : spike strict and lax, 1–3 dm. long ; bracts ovate-lanceolate, acuminate, two-thirds as long as the flowers : these yellowish-green, about 10 mm. long : sepals and petals about 4 mm. long, obtuse ; upper sepal ovate ; lateral sepals and petals oblong lanceolate ; lip ovate, rounded at the apex, somewhat hastate at the truncate base, but the lobes rounded, rather thick and with prominent ridge in the middle ; spur thick, decidedly clavate, about equalling the lip, but much shorter than the ovary. (Fig. 27.)



FIG. 27.

I have not seen the type, collected by Cooper at San Diego, California, but the plants cited below agree with the description and were collected in the same region. It is from these I have drawn the description and figure.

TYPE : "On Clay hills near San Diego, California ; Dr. J. G. Cooper."

CALIFORNIA : San Diego, 1884, *C. R. Orcutt* ; Point Loma, 1897, *T. S. Brand* *gce*.

3. *Piperia lancifolia* sp. nov.

Stem stout, 3-5 dm. high, the lower portion leafy; basal leaves and lower stem-leaves lanceolate, attenuate, 10-15 cm. long, 1-2 cm. wide, withering after anthesis; spike many-flowered, but lax, 2-3 dm. long; bracts ovate, acute, striate, about two-thirds as long as the flowers, or the lower almost equalling them; flowers greenish, 11-13 mm. long: upper sepal ovate, obtuse, about 4 mm. long; the lateral ones slightly longer, oblong-lanceolate; petals lanceolate, obtusish, oblique at the base; lip about 4 mm. long; blade round ovate, rounded at the apex, truncate at the base, scarcely at all hastate, thick, with prominent median ridge; spur filiform, slightly clavate, almost twice as long as the lip and about equalling the ovary. (Fig. 28.)



FIG. 28.

This species is closely related to the preceding, differing in the longer less clavate spur, scarcely at all hastate lip and broader bracts. It is growing in cañons.

CALIFORNIA: Sierra Santa Monica, 1892, *H. E. Hasse*, 5675 (type in herb. N. Y. Bot. Gard.).

4. *Piperia leptopetala* sp. nov.

Stem slender, 3-4 dm. high, leafy only at the base: basal leaves two, oblong-lanceolate, obtuse or acutish, about 1 dm. long, 1.5-2.5 cm. wide, withering at anthesis or soon after; stem leaves all reduced and bract-like, few, lanceolate, acute: spike slender, lax, 1-2 dm. high; bracts lanceolate to linear-lanceolate, acuminate, about half as long as the flowers: these greenish, about 1 cm. long: upper sepal lanceolate, obtuse, about 4 mm. long; lateral ones narrowly lanceolate, acute, about 5 mm. long: petals narrowly lanceolate, acute,



FIG. 29.

about equalling the upper sepal; blade of the lip lanceolate, obtuse, hastately toothed at the base; median ridge rather obscure; spur filiform, not clavate, about twice as long as the lip and longer than the ovary. (Fig. 29.)

In habit this species resembles most *P. Unalaschensis*, but the sepals and petals are narrower and the spur is almost twice as long.

CALIFORNIA : Mountains east of San Diego, 1850, *C. C. Parry* (Mex. Bound. Surv., type in herb. Columbia Univ.); Plumas county, 1875, *Mrs. Austin*.

WASHINGTON : Nesqually River, 1838-42, *Wilkes Exp.*, 146, in part.

5. *Piperia multiflora* sp. nov

Montolivaca elegans Rydb. Mem. N. Y. Bot. Garden, 1 : 106, in part as to specimen cited. 1900 ; not Reichenb. 1881 ; *Piperia elegans* Rydb. Bull. Torr. Club, 28 : 270, in part. 1901.



FIG. 30.

Stem stout, 4-6 dm. high, 3-4-leaved only near the base : basal leaves oblong, oblanceolate or obtuse or acutish, 1-1.5 dm. long, 2-3 cm. wide, withering at anthesis ; lower stem leaves lanceolate, acute ; upper stem leaves much reduced and bract-like, lanceolate or linear-lanceolate, scattered, attenuate, 1-2 cm. long : spike very dense, 1-2 dm. long ; bracts linear-lanceolate, almost equalling the flowers : these greenish-white, spreading, about 1.5 cm. long : upper sepal lanceolate, acute, 4-5 mm. long ; lateral

sepals and petals linear-lanceolate, acutish or obtuse ; lip almost linear, obtuse, only slightly hastate at the base, about 6 mm. long ; median ridge very low ; spur 15-18 mm. long, filiform, not clavate. (Fig. 30.)

This species is perhaps nearest related to *P. elegans*, differing however in the dense spike, the spreading flowers, and narrow petals and sepals.

WASHINGTON : Gray's Harbour, 1838-42, *Wilkes Exped.*, 194 (type in herb. Columb. Univ.) ; Cascade Mountains, 1882, *Brandegee*, 475.

MONTANA : Mission Range, 1883, *W. M. Canby*, 307.

CALIFORNIA : Monterey, *Wm. Rich*.

6. *PIPERIA ELEGANS* (Lindl.) Rydb. Bull. Torr. Club, 26 : 270 in part. 1901

Platanthera elegans Lindl. Gen. & Sp. Orchid. Pl. 285. 1835 ; *Montolinaca elegans* Rydb. Mem. N. Y. Bot. Gard. 1 : 106, in

part, as to synonym. 1900; not Reichenb. 1881; *Piperia elongata* Rydb. Bull. Torr. Club, 28: 270. 1901.

Stem slender, strict, 4-7 dm. high: tuber ellipsoid, about 2 cm. long, 1 cm. in diameter: basal leaves 2 or 3; blades lanceolate or oblanceolate or rarely oval, acute or obtuse, 8-15 cm. long, 1-3, sometimes even 5 cm. wide; stem-leaves much reduced, lanceolate, acuminate, 5-10 mm. long: spike long and usually lax, 1.5-3 dm. long; bracts lanceolate, acuminate, from half to fully as long as the flowers: these greenish-white, about 1 cm. long: sepals about 5 mm. long; the upper lanceolate, acute; the lateral ones linear-oblong or lanceolate, obtuse: petals lanceolate, acute; blade of the lip broadly or ovate-lanceolate, slightly hastate and truncate at the base; median ridge rather indistinct; spur filiform, 10-12 mm., about two and a half times as long as the lip and longer than the ovary. (Fig. 31.)



FIG. 31.

TYPE: "In *America boreali occidentali*, Douglas (hab. s. sp. comm. Soc. Hort.)."

BRITISH COLUMBIA: Vancouver Island, 1887, John Macoun.

WASHINGTON: W. Klickitat county, 1885, W. N. Suksdorf.

OREGON: Grave Creek Hills, 1887, Thomas Howell; 1871, Elihu Hall, 506.

IDAHO: Priest Lake near lower end, 1900, D. T. MacDougal, 168; Priest River valley, 134; Kootenai county, 1887, J. H. Sandberg; Wiessner's Peak, 1892, Sandberg, MacDougal & Heller, 584 (broad leaved).

CALIFORNIA: Santa Lucia Mountains, 1898, R. A. Plaskett, 167; 1872, Mrs. Bancroft.

7. *Piperia longispica* (Durand)

Gymnadenia longispica Durand, Pl. Pratten, 101. 1855.

Stem stout, 3-7 dm. high, more or less leafy below: tuber ellipsoid, 3-4 cm. long, about 1.5 cm. thick, basal leaves and lower stem leaves 2-4, lanceolate, acute, 1-1.5 dm. long, 2-3.5 cm. wide, withering about the time of anthesis: upper stem leaves reduced, 1-3 cm. long, lanceolate: spike many-flowered, but not dense, 1-3 dm. long; bracts ovate-lanceolate, .5-1 cm. long, acuminate: flowers greenish, about 1.5 cm. long: upper sepal ovate, obtuse,

about 5 mm. long ; lateral sepals oblong-lanceolate, obtuse : petals broadly lanceolate ; blade of the lip ovate-hastate, distinctly auricled, and truncate at the base ; spur filiform, two and a half times as long as the lip. (Fig. 32.)



FIG. 32.

I have not seen the type of *Gymnadenia longispica*, which was described from a fragmentary specimen collected by Pratten, *i. e.*, it consisted only of the upper portion without any leaves. Durand's species has been regarded as *P. Unalaschensis* but this cannot be so, for *Gymnadenia long-*

ispica was described as having a spur longer than the ovary, which throws it out of *P. Unalaschensis*. As the spike is described as long and lax it must have been either *P. elegans*, *P. leptopetala* or the species described here. As this is the only species with broad bracts, the name *G. longispica* must belong here, unless it is a species unknown to me. The only discrepancy is that the spur is described as clavate, which is scarcely the case.

CALIFORNIA : Mokelumne River, *Mr. Rich* ; Monterey, 1850, *C. C. Parry* (Mex. Bound. Surv.) ; Cucamonga Mts., 1881, *S. B. & W. F. Parish*, 1157 ; Santa Monica range, 1892, *H. E. Hasse*.

8. *Piperia Michaeli* (Greene)

Habenaria elegans Boland. (Cat. Pl. San Franc. 29) ; *S. Wats. Bot. Calif.* 2 : 133. 1880 ; not *Platanthera elegans* Lindl. 1835 ; *Habenaria Michaeli* Greene, Man. Bay-Reg. Bot. 306. 1894 ; *Montoliveia elegans* Rydb. Mem. N. Y. Bot. Gard. 1 : 106, in part as to synonym, 1900 ; *Piperia elegans* Rydb. Bull. Torr. Club, 28 : 270, in part as to synonym.

Stem stout, at flowering time leafless, 2-3 dm. high : tuber ellipsoid, 2-4 cm. long, 1-1.5 cm. wide : basal leaves elliptic or oblanceolate, about 1.5 dm. long, 4 cm. wide, withering before blooming ; stem-leaves numerous, small and bract-like, lanceolate to ovate-lanceolate, acuminate,



FIG. 33.

1-2 cm. long: spike very dense, 5-15 cm. long: flowers about 1 cm. long, greenish: upper sepal ovate, about 4 mm. long; lateral ones oblong-lanceolate, obtuse: petals lanceolate, acute; blade of the lip ovate, obtuse, scarcely hastate, obtuse or truncate at base; spur filiform, about two and a half times as long as the lip and a third longer than the ovary. (Fig. 33.)

TYPE: "Open hills, under oaks, etc., from near Livermore southward."

CALIFORNIA: San Luis county, 1886, *G. W. Michael*; Stansbury Valley, 1876, *Harry Edwards*; San Francisco, 1838-42, *Wilkes Expedition*, 1554, in part; "California," *Bolander*.

WASHINGTON: Gray's Harbor, 1838-42, *Wilkes Expedition*, 1554, in part; Nesqually River, 146, in part.

9. *Piperia maritima* (Greene)

Habenaria maritima Greene, *Pittonia*, 2: 298. 1892.

Stem stout, 2-3 dm. high, at flowering time leafless: tuber almost spherical, 2-2.5 cm. in diameter: leaf-blades oblong, obtuse or acute, about 1 dm. long, 3-4 cm. wide, withering before anthesis; stem leaves reduced and bract-like, numerous, ovate-lanceolate, acuminate, 1-2 cm. long: spike short and very dense, 4-10 cm. long; bracts about two-thirds as long as the flowers: these 10-12 mm. long, white: upper sepal ovate, obtuse, about 4 mm. long; lateral sepals oblong-lanceolate: petals broadly lanceolate; blade of the lip elliptic, obtusish, scarcely hastate, somewhat truncate at the base, as well as the petals and sepals, white, thin; spur filiform, about 2.5 times as long as the lip and longer than the ovary. (Fig. 34.)



FIG. 34.

This differs from all the other species in its stoutness and white flowers. It resembles most *P. Michaeli* in habit, the short spike, numerous scale-like stem leaves and the absence of root leaves at the time of flowering.

TYPE: "On dry hills near the sea at Point Lobos, near San Francisco."

CALIFORNIA: San Francisco county, 1892 and 1893, *Michener & Bioletti*.

CROSS-REFERENCES AND INDEX

- BLEPHARIGLOTTIS Raf., 605-6.
 COELOGLOSSUM Hartman., 605.
 GYMADENIA., 605-6
 longispica Durand = P. *longispica*.
 GYMADENIOPSIS Rydb., 605-6.
 HABENARIA Willd., 605.
 borealis Cham. = L. *borealis*.
 —3 *viridiflora* Cham. = L. *viridiflora*.
 brevifolia Greene = L. *brevifolia*.
 Cooperi S. Wats. = P. *Cooperi*.
 dilatata Coult. = L. *borealis*.
 —Hook. = L. *dilatata*.
 —Torr. = L. *media*.
 dilatatifolmis Rydb. = L. *borealis*.
 elegans Bolander = P. *Michaeli*.
 foetida S. Wats. = P. *Unalaschensis*.
 gracilis S. Wats. = L. *stricta*.
 graminea Spreng. = *Plathantha graminea* Lindl.
 hyperborea R. Br. = L. *hyperborea*.
 —Gray = L. *major*, L. *media*, L. *Huronensis*.
 —Rothr. = L. *stricta*.
 —Wats. = L. *viridiflora*.
 leucostachys S. Wats. = L. *Thurberi*, L. *leucostachys*.
 maritima Greene = P. *maritima*.
 Michaeli Greene = P. *Michaeli*.
 pedicellata S. Wats. = ?.
 saccata Greene = L. *stricta*.
 Schischmareffiana = P. *Unalaschensis*.
 sparsiflora Wats. = L. *sparsiflora*.
 stricta Rydb. = L. *stricta*.
 Thurberi A. Gray = L. *Thurberi*.
 Unalaschensis Wats. = P. *Unalaschensis*.
 HERMINIUM., 633.
 Unalaschense = P. *Unalaschensis*.
 LIMNORCHIS Rydb., 606.
 ARIZONICA Rydb., 629.
 BEHRINGIANA Rydb., 620.
 BOREALIS (Cham.) Rydb., 621.
 BRACHYPETALA Rydb., 616.
 BREVIFOLIA (Greene) Rydb., 631.
 CONVALLARIAEFOLIA (Lindl.) Rydb., 628.
 LIMNORCHIS Rydb.
 DILATATA (Pursh) Rydb., 622.
 —LINEARIFOLIA Rydb., 623.
 dilatatifolmis Rydb. = L. *borealis*.
 ENSIFOLIA Rydb., 629.
 FOLIOSA Rydb., 622.
 FRAGRANS Rydb., 623.
 GRACILIS (Lindl.) Rydb., 627.
 GRAMINIFOLIA Rydb., 627.
 HURONENSIS (Nutt.) Rydb., 619.
 HYPERBOREA (L.) Rydb., 620.
 hyperborea Rydb. = L. *viridiflora*, L. *major*.
 LAXIFLORA Rydb., 630.
 LEPTOCERATITIS Rydb., 624.
 LEUCOSTACHYS (Lindl.) Rydb., 625.
 —ROBUSTA Rydb., 626.
 MAJOR (Lange) Rydb., 617.
 MEDIA Rydb., 618.
 PURPURASCENS Rydb., 615.
 SPARSIFLORA (S. Wats.) Rydb., 631.
 STRICTA (Lindl.) Rydb., 614.
 THURBERI (A. Gray) Rydb., 624.
 VIRIDIFLORA (Cham.) Rydb., 616.
 LYSIELLA Rydb., 606.
 MONTOLIVAEA Reichenb., 635.
 ELEGANS Reichenb., 639.
 elegans Rydb. = P. *elegans*, P. *multiflora*, P. *Michaeli*.
 Unalaschensis Rydb. = P. *Unalaschensis*.
 ORCHIS L., 605.
 dilatata Pursh = L. *dilatata*.
 dolichorhiza = ?, 608.
 Huronensis Nutt. = L. *Huronensis*.
 hyperborea L. = L. *hyperborea*.
 Koenigii Retz. = L. *hyperborea*.
 ROTUNDIFOLIA Pursh., 605.
 PERULARIA Lindl., 605.
 PIPERIA Rydb., 632.
 COOPERI (S. Wats.) Rydb., 636.
 ELEGANS (Lindl.) Rydb., 638.
 elegans Rydb. = P. *multiflora*, P. *Michaeli*.
 elongata Rydb. = P. *elegans*.
 LANCIFOLIA Rydb., 637.
 LEPTOPETALA Rydb., 637.

PIPERIA Rydb.

LONGISPICA (Durand) Rydb., 639.

MARITIMA (Greene) Rydb., 641.

MICHAELI (Greene) Rydb., 640.

MULTIFLORA Rydb., 638.

UNALASCHENSIS (Spreng.) Rydb. 638.

PLATANATHERA Rich., 605.

convallariaefolia Lindl. = *L. convallariaefolia*.

dilatata Beck = *L. Huronensis*, *L. dilatata*.

—Lindl. = *L. borealis*, *L. dilatata*.

—Torr. = *L. major*, *L. dilatata*.

gracilis Kraenzlin = *L. stricta*.

—Lindl. = *L. gracilis*.

GRAMINEA (Spreng.) Lindl., 627.

graminea Lindl. = *L. graminifolia*.

foetida Geyer = *P. Unalaschensis*.

Huronensis Lindl. = *L. Huronensis*.

hyperborea Lindl. = *L. hyperborea*.

—*a. genuina* Kraenzlin = *L. hyperborea*, *L. viridiflora*, *L. major*, *L. media*.

PLATANATHERA Rich.

—*3. convallariaefolia* Kraenzlin
L. convallariaefolia.

—*3. major* Lange = *L. major*.

—*γ dilatata* Kraenzlin = *L. dilatata*, *L. Huronensis*, *Habenaria pedicellata* S. Wats., *P. Cooperi*, *L. graminifolia*, and *L. borealis*.

—*γ leucostachys* Kraenzlin I..
leucostachys, *L. brevifolia*,
Platanthera Ghiesbreghtiana
Rich. & Gal., *L. sparsiflora*,
L. Thurberi, *L. ensifolia*.

Koenigii Lindl. = *L. major*.

—*β dolichorhiza* Lindl. = *Orchis dolichorhiza* = ?.

leucostachys Lindl. = *L. leucostachys*.
Schischmareffiana = *P. Unalaschensis*.

stricta Lindl. = *L. stricta*.

Unalaschensis Kraenzlin = *P. Unalaschensis*.

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SEEDS AND SEEDLINGS OF ARISAEMA TRI-
PHYLLUM AND ARISAEMA DRACONTIUM

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Seeds and Seedlings of *Arisaema triphyllum* and *Arisaema Dracontium*

BY ROSINA J. RENNERT

(PLATE 3)

Some interesting facts in the germination of the seeds of *Arisaema Dracontium* have been recently described by Dr. MacDougal, and the author has devoted a greater part of the last year to the comparative study of the morphology and physiology of the seedlings of this species and of *A. triphyllum*. Some attention was also given to seedlings of a hybrid between the two species and those of *A. flavum* from Sikkim, India.

It was previously found by Dr. MacDougal that the plumule of *A. Dracontium* emerges from the cotyledonary sheath only in a small proportion of the seedlings, and that only a few of those emerging exhibited a development sufficient to carry the lamina of the first leaf up into the air and unfold it to the light.*

According to Braun, the closely related species *Arum maculatum* displays a similar behavior. He says "So spielt auch an der Keimpflanze die Niederblattbildung eine grossere Rolle, als bei *Calla*, in dem nach Irmisch auf dem Cotyledon zunächst mehrere unterirdische vegetirende Niederblatte folgen bevor ein Laubblatt, und zwar erst im zweiten Jahre zum Vorschein kommt."† This statement seems to have escaped the notice of Scott and Sargent who have recently made an extended study of these seedlings.‡

The seedlings of *A. triphyllum*, on the other hand, send up a plumule as soon as the hypocotyl is firmly established in the soil, while the hybrid between *A. Dracontium* and *A. triphyllum* displays a curiously intermediate type of germination. The hypo-

* MacDougal, D. T. Seedlings of *Arisaema*. *Torrey*, 1: 2. 1901.

† Braun. Ueber das Vorkommen mehrerer Hüllblätter am Kolben von *Arum maculatum* L., *Calla palustris*, und *Richardia Africana* Kth. *Verh. bot. Ver. Brandenburg*, 1: 94. 1859.

‡ Scott and Sargent. On the Development of *Arum maculatum* from the Seed. *Annals Bot.* 12: 399. 1898.

cotyl, in this case, increases in size at first without sending up a plumule, and it is only after the seedling has exhausted the entire food supply of the endosperm and has separated from the seed that the plumule appears.

Like *A. triphyllum* the Indian species, *A. flavum*, follows the normal type of germination, and its plumule arises shortly after the hypocotyl emerges from the seed. The seedling is only about one half the size of that of *A. triphyllum*.

As the general structure of the seedling of *A. triphyllum* resembles most closely that displayed by *A. Dracontium*, this species was chosen as a basis for comparison in the study of the curious variations of *A. Dracontium*.

The fruits of *A. Dracontium* and *A. triphyllum* are very similar. In both the scarlet berries, which have a sweetish, slightly acrid taste, are closely crowded upon the spadix. The berries of *A. Dracontium* are larger and fleshier than those of *A. triphyllum* and contain from three to six seeds, while those of *A. triphyllum* are one- or three-seeded. In shape the seeds of both are somewhat ovoid. At the hilum, the seed of *A. Dracontium* is generally puckered into two or three ridges and the short stalk of the funiculus is conspicuous, while in *A. triphyllum* the seed is flattened in the hilar region, but also bears a prominent funiculus. Elsewhere the seeds are well rounded, except when flattened by the pressure of other seeds in the same berry. Both seeds bear a rudimentary aril which consists of a small disc-shaped fleshy mass situated immediately inside the coats at the hilar end of the seed, and extending as a core down the funiculus. The average size of the seeds of *A. Dracontium* is 3.5 mm. in transverse and 4.25 mm. in longitudinal diameter, while the average seed of *A. triphyllum* is 4 mm. in transverse and 3.5 mm. in longitudinal diameter, almost exactly reversing the proportions of *A. Dracontium*. When only a few are produced in a berry, the seeds of *A. Dracontium* are larger in both axes than those of *A. triphyllum*, which develop singly. When, however, a number of seeds mature in the same berry they develop in such a position as to exert a lateral pressure upon each other and in consequence the transverse diameter remains shorter. In these cases the seeds of *A. Dracontium* do not attain the size of even the smallest of *A. triphyllum*. On the whole, however, *A.*

Dracontium has the larger seed. The surface of both seeds is finely pitted and sometimes minute reddish spots are to be seen upon them. *A. triphyllum* has a yellowish color and *A. Dracontium* a reddish-yellow blush. This color is due to substances in the wall of the inner coat of the seed, as the testa is translucent.

In the general microscopic structure the seeds present only slight dissimilarities. The outermost row of cells in the testa of both species are brick-shaped and are set close together with their long axes at right angles to the radius of the seed. In both the walls of this outer row of cells are mucilaginous, swelling greatly when they come in contact with water. In *A. Dracontium* they are slightly larger and their outer walls are considerably thicker. A cuticle covers this row of cells in both species. Some of the cells below the outer row of the testa contain tannin, others are filled with mucilage in which raphide cells are imbedded, still others have a red coloring matter within them. It is to these latter cells that the dotted appearance sometimes noted on the seeds is due. The tegmen consists of three rows of tabular cells with very thick mucilaginous walls. In *A. Dracontium* these walls are orange-colored, and in *A. triphyllum* yellowish in color and so serve to give each seed its distinctive appearance. There is a cutinized lamella on either side of the tegmen cells.

The seeds of both plants are orthotropous and the embryo is imbedded in an abundant endosperm. In *A. triphyllum* the endosperm appears entirely homogeneous to the naked eye, while in *A. Dracontium* there is a horny layer next the seed coats. Upon microscopic examination, however, but slight differences are evident. The outer portion of the endosperm of *A. Dracontium* consists of 3 to 5 rows of cubical aleurone cells with walls capable of great swelling in water. These cells contain granular proteid globules, a single crystalloid, and also a small amount of fat. The aleurone cells of *A. triphyllum* are of exactly the same character, but are generally only from two to four rows deep, and also a trifle smaller. Within the layers of aleurone cells, making up by far the greater part of the endosperm, are large starch-bearing cells which have thin cellulose walls. Numerous crystalloids are imbedded in the starch of these cells. These crystalloids are slightly more numerous in the seeds of *A. Dracontium*. In both cases, however,

they are very abundant near the aleurone cells and become scarcer toward the embryo at the center of the endosperm. It will be seen that the only difference between the two seeds lies in the size of the cells which compose the aleurone layer and the seed coats. It follows from the greater size of the seed of *A. Dracontium* that this species has a food supply slightly greater than that of *A. triphyllum*.

Both resting embryos occupy a position near the base of the seed. In fact the aleurone cells near the micropyle are obliterated and the base of the hypocotyl of each embryo is close to the tegmen at this point. The cavity in which the embryo lies, but does not entirely fill, corresponds in general shape to that of the embryo and extends as an axis from the micropyle to the hilar region through the center of the seed. Its sides are formed of starch-bearing cells, aleurone cells close to the cavity at the hilar end, while the tegmen bounds it at the opposite end as described above. The embryos are club-shaped and small in proportion to the amount of endosperm contained in the seeds. In *A. Dracontium* they are 2 mm. long and .75 mm. thick, while those of *A. triphyllum* are slightly larger, measuring 2.75 mm. in length and .5 to .875 mm. in thickness. In *A. triphyllum* three fourths of the length of the embryo consists of cotyledon, the remainder is taken up by the hypocotyl. This relation is different in *A. Dracontium*, for the cotyledon in this case bears a slightly greater proportion to the entire length of the embryo. A slight constriction marks the insertion of the cotyledon on the hypocotyl, and a very small protuberance at the base of the hypocotyl is the incipient radicle.

Five regions are already differentiated in the resting embryo of each species, the dermatogen, procambium, root cap, meristem and fundamental parenchyma. The dermatogen is continuous with the epithelial layer which covers the entire embryo and, at the slit for the emergence of the plumule in the cotyledonary tube, is deflected back to line the plumular cavity. In the plumule of *A. triphyllum* dermatogen is already clearly differentiated but in *A. Dracontium* it is not so evident. The dermatogen is composed of a single row of narrow cells with their long axis at right angles to the longitudinal axis of the embryo. They are filled with aleurone grains and each contains a crystalloid. The procambium

strands which foreshadow the bundles have already been laid down in the cotyledon, stem-bud and hypocotyl. Near the tip of the cotyledon the procambium strands branch and anastomose irregularly and therefore no definite number or arrangement of them can be determined, but at the base the number becomes constant and each strand occupies a regular position. The plan of arrangement in both species is similar. In cross section the strands mark out a crescent in which the largest is at the middle of the bow. In *A. triphyllum* which has regularly five strands, two lie on either side of the central ones, while the cotyledon of *A. Dracontium* shows the same arrangement of its five principal strands, but has in addition one or two smaller ones. When there are two, these extra strands occupy positions on either side of the large middle trace. When only one extra strand is retained, it invariably is at the right. In the tubular portion of the cotyledon, the largest strand is in the thickest part of the wall. The strands are composed of six or seven rows of narrow elongated cells which have their long axis four to six times the length of their radial, and parallel with the longitudinal axis of the embryo. In the stem-bud, procambium strands have also been differentiated. In *A. Dracontium* the strands in the plumule are faint and there is some variation in the number of the procambial regions. They are never more numerous than three and at times only the pro-cambium of the future midrib has been laid down. In *A. triphyllum* five distinct procambium regions can be distinguished in the plumule. Procambium strands are also present in the hypocotyl and occupy fully one half of its entire diameter. They are continuous with the procambium of the stem-bud and form at the base of the hypocotyl the rudimentary root stele. At the base of the hypocotyl the root-cap may be distinguished, made up of several rows of rather large cells which stretch across its entire base and are continuous at the sides with the dermatogen of the embryo. In the outer rows the cells are empty. Meristem tissue is to be found at the stem-bud and at the base of the hypocotyl where the root takes its origin. These cells are very small and nearly isodiametric. Their nuclei are large and fill almost the entire cell. Parenchyma cells make up the rest of the embryo. They are two or three times the size of the epidermal cells and are packed with

starch. Scattered through the inner tissue are large cells filled with proteids in which a crystalloid also is embedded. These proteid cells are distributed through the tissues in those regions where the pro-cambium strands first make their appearance.

The embryos of the two species are similar in shape, position in the seed and general structure. *A. Dracontium* differs from *A. triphyllum* in four particulars: (1) Its size, (2) The proportion which the length of its cotyledon bears to its hypocotyl, (3) The number of procambium regions to be found in the cotyledon and (4) The state of differentiation of the procambium strands in the plumule. Here already the tendency in *A. Dracontium* to delay the development of the plumule is evident.

THE GERMINATION OF THE SEEDLINGS

In both species when water reaches the seeds the mucilaginous walls of the outer row of cells of the testa swell, while the cells below, pulled out by the swelling outer row and pushed out by the increase in size of the mucilaginous tegmen and the walls of the aleurone cells, separate and show an irregular alternation of large and small cells, which are, of course, empty. The seeds now increase considerably in size by the absorption of water, and the action of the moisture slowly reduces the outer row of the testa cells to a gelatinous film about the seeds. The mucilaginous tegmen is also soon dissolved, while all that remains of the seed coat is the inner part of the testa. The tannin in the vesicles contained within this becomes diffused through the whole of the cellulose coat and makes it more resistant to the disintegrating action of the soil. This part of the coat alone adheres to the seed until the last particle of endosperm is dissolved. The mucilaginous cells of the seed coat and the thick walls of the aleurone cells serve to increase the absorption of water, while the outer row of the testa is instrumental in bringing about the attachment of the seed to the soil.* The cellulose layer of the testa, impregnated with tannin, protects the endosperm during germination. When water reaches the embryo in the seed it swells and fills the cavity in which it lies, so that its epithelial cells are in contact at the sides with the starch

* Klebs. Beiträge zur Morphologie und Biologie der Keimung. Untersuch. a. d. Botan. Institut z. Tübingen. 1: 536. 1885.

cells of the endosperm. Here the diastase formed by the epithelium of the embryo can begin to act upon the stored starch of the seed and a proteolytic enzyme to dissolve the crystalloids. The starch of the endosperm is absorbed before the crystalloids, and when the cells in contact with the embryo have been emptied of their contents the cell walls are pushed back by the advancing growth of the cotyledon and the enzyme acts upon the contents of the cells next outside. The proteids of the aleurone cells do not become soluble until late in the history of the seedling. The cell walls of the endosperm do not seem to be acted upon by any enzyme, and are wholly intact until the seed separates from the seedling.

While the epithelial cells are secreting the enzymes, the cotyledon increases in length and by its elongation pushes the hypocotyl, bearing the stem-bud, through the seed coats at the micropyle. *A. Dracontium* requires fully a month longer than *A. triphyllum* for its hypocotyl to protrude. When the hypocotyl has wholly emerged from the seed it is directed down into the ground at right angles to the plane of the cotyledon, which is still in the seed. This is effected by means of a bend in the cotyledon at the place where it leaves the seed. This downward pull of the hypocotyl serves to tilt the seed up, and is sufficient when the seed has not been planted deep to break through the ground and bring the seed to the surface. In all cases it loosens the earth about the seedling, and so renders it easier for the plumule to make its way through the soil.

A great part of the cotyledon is confined within the seed during its entire development. The length which the cotyledons attain varies in both species, but those of *A. Dracontium* are on the average shorter than those of *A. triphyllum*. The average length of the *A. Dracontium* cotyledons outside of the seed is 3 mm., while those of *A. triphyllum* reach an average length of 7 mm. The number of the cells in the cotyledon is not increased by its elongation, for its entire growth is due to the increase in size of the already existing cells. The epithelial cells, which in the resting embryo had their axis perpendicular to the longitudinal axis of the embryo, now in the region of the cotyledon have this relation completely changed. Their long axes are parallel with the longitudinal

axis of the embryo. The cells of the parenchyma have also taken on an elongated form. The only region in the cotyledon where new cells are added is that occupied by the procambium and fibrovascular bundles. Here the cell division is very active. Radial growth takes place only as the contents of the endosperm cells is absorbed. The shape, arrangement of cells and manner of elongating are exactly similar in the cotyledons of *A. Dracontium* and *A. triphyllum*. It is only in the fibrovascular system that any difference between them has been discovered. Here in both cases, as in the procambium strands in the embryo, the bundles near the tip, branch and anastomose so that their distribution is irregular. At the base, however, the number of bundles is constant. *A. Dracontium* as a rule possesses six bundles : one of these strands is very weak and occupies the same position as the sixth procambium strand in the cotyledon, *i. e.*, at the right of the largest central bundle. The left hand strand which corresponds to the seventh in the resting embryo disappears before the cotyledon has proceeded very far with its development. The cotyledon of *A. triphyllum* has five bundles arranged as in the resting embryo. In a few instances chlorophyll has been found in that part of the cotyledon of *A. Dracontium* which protrudes from the seed both when the plumule was functional and when it was not. These cases, however, are uncommon.

Up to this point there is almost absolute identity in the germination of these two species : the only difference between them lies in the various sizes which the cotyledons attain. After this stage in the germination has been reached, however, various differences in the order of development of the organs become apparent.

The rudiments of all the structures of the mature corm are present in the hypocotyl of both *A. triphyllum* and *A. Dracontium* and the formation of the corm is brought about by the enlargement of the base of the hypocotyl and the laying down in it of the definitive tissues. In both it increases in bulk at least to a small extent before the first primary root is sent out. The hypocotyl of *A. Dracontium* enlarges at a very much more rapid rate in the first stages of germination than does *A. triphyllum* and generally attains a considerable development before the root appears. A seedling of *A. Dracontium* with two roots each only 1 mm. in length

may have a corm 4 mm. in diameter while in a well-developed seedling of *A. triphyllum* with a strong system of roots and a plumule well grown, the corm may be only 1.75 mm. in diameter. The enlargement of the corm of *A. triphyllum* becomes marked only after the leaf is well established as a photosynthetic organ. In those seedlings of *A. Dracontium* in which the plumule does not become functional the corm, when its growth is completed, averages 4.5 mm. in diameter. When, however, the seedling has a functioning leaf the corm may attain a diameter of 6 mm. The corm of *A. triphyllum* may have a diameter of 5.75 mm. at the end of the season, but in many cases it is much less.

The enlargement of the hypocotyl is due to the increase both in size and number of its cells. As its growth is rather radial than longitudinal, the epithelial cells become isodiametric in shape. The storage cells increase in size and in number in all directions and so maintain the same relative dimensions. The starch grains contained in these cells are several times as large as those of the endosperm of the seed. The procambium cells of the hypocotyl are very active, dividing both in their longitudinal and transverse diameters and the fibro-vascular system soon becomes differentiated. Raphide cells are numerous in the corm and in all parts of the seedlings of the two species. As the corm enlarges, a layer of periderm arises on the outside, from which are cut off tangentially five or six rows of empty flattened cells. In addition to the protection they afford the corm, these periderm cells are instrumental in effecting a separation between the cotyledon and the corm, after the food supply of the endosperm has been absorbed. They grow between the cotyledon and the corm and separate the two by proliferating cells from their surface. In several instances chlorophyll has been formed in the two or three rows directly beneath the layers of periderm. The only difference in the development of the corm of the two species lies in the earlier enlargement of the hypocotyl of *A. Dracontium* and the greater average size of its completed corms.

The time at which the roots of *A. Dracontium* appear varies markedly. In some cases the hypocotyl enlarges greatly, becoming, as was described above, about 3 mm. in diameter before the first root arises. In other instances the roots are developed as

soon as the hypocotyl has found its way into the ground. Seedlings of *A. Dracontium* vary greatly also in the number and kinds of roots which they send forth. Those with the most well developed system have two primary roots from the base of the hypocotyl and later a thick root arising adventitiously from the the nodes. This secondary root, becomes contractile and transversely ridged for part of its length. One of the primary roots also often becomes contractile and helps to draw the corm deeper in the ground. A secondary root, however, is developed only in those seedlings which also send up a plumule and a few even of these have none. The seedlings in which the plumule has not started into activity have as a rule two primary roots, one of which becomes thickened and assumes the function of contraction. In some cases neither of the primary roots is contractile and in others only one short thin root is produced. A direct correlation between leaf and root development is here evident. Variations in the structure as well as the number of the roots occur. The contractile roots which are for the most part simple have been observed occasionally to be branched. In another instance (the single case in which two contractile roots occurred in the lot of *A. Dracontium* seedlings observed) two contractile roots were fused for part of their length. The root system of *A. triphyllum* is very much better developed than is that of *A. Dracontium*, for the roots are both longer and more numerous. The seedlings have always two and often three primary roots which reach a length of 5 cm. and in addition after the seedling is well under way, three thick adventitious roots appear, budding from the nodes. These roots are contractile and show the same transverse ridges as the contractile roots of *A. Dracontium*. In some cases they pull the hypocotyl down as much as 2 or 3 cm. below the level at which it germinated. After the secondary roots become firmly established, the primary roots grow no more and the greater part of the entire root function is discharged by the contractile roots which bear root hairs near their tips and become about 7 cm. long.

The only difference in microscopic structure between the contractile, secondary and primary roots consists in the greater radial elongation of the cells of the inner cortex of the contractile roots. In *A. Dracontium* the root stele of the primary root shows a diarch

structure and the secondary roots are tetrach as a rule. Some, however, have been observed to be triarch; in *A. triphyllum* both primary and contractile roots are triarch. After the contraction of the roots the outer cortex cells are very much strained and twisted, but the radial elongation of the inner cells protects the stele from any distortion. The roots of *A. Dracontium* are more variable in all respects than those of *A. triphyllum*.

The stem-bud of *A. Dracontium* and *A. triphyllum* have the same structure in the resting embryo, with the exception that the procambium stands in the bud leaves have reached a more advanced stage of differentiation in *A. triphyllum*. During the first season's growth, however, the structure of the bud in the two species has an entirely different history. Like the roots the plumules of the *A. Dracontium* seedlings vary greatly in the state of development which they attain. As a rule the plumule of *A. Dracontium* develops to at least a small degree after germination, forming a lamina and a short petiole which although it may break through the cotyledonary sheath, yet rarely reaches the air and is often represented only by a rudiment 2 mm. in length remaining permanently enclosed by the cotyledon and enveloping in its turn the stem-bud of the next year. This undeveloped plumule is cut off at the end of the season by the formation of a periderm between it and the corm in the same way as the cotyledon is separated from the corm. About 10 per cent. of the seedlings of *A. Dracontium* produce functional plumules. They appear at different stages during the growth of the corm, generally when it has already attained a considerable size and in some cases only after the seedling has entirely separated from the seed. Its method of emergence from its enclosing cotyledon is exactly the same as that of *A. triphyllum* which produces a plumule normally. As soon as the root has secured a firm hold on the soil and the hypocotyl is only slightly enlarged, the plumule with its blade recurved parallel to the petiole and rolled in at the margin breaks through the tubular part of the enclosing cotyledon through a longitudinal slit which is already present in the resting embryo. The plumule becomes green rapidly while the petiole at the base of the lamina straightens out and the folded blade unrolls and grows larger.

The functional plumules of *A. Dracontium* exhibit a tendency toward degeneration. A comparison of the plumules of the two species will well demonstrate the particular instances. The fully grown leaves of *A. triphyllum* are ovate, the largest being 36 mm. in length and 30 mm. in width, while the smaller are 25 mm. by 13 mm. The functional leaves of *A. Dracontium* vary greatly in the shape and size of the lamina and in the length of the petiole. In outline they range from broadly elliptical to nearly circular and all bear a mucronate point at the tip as does *A. triphyllum*. The largest leaves of *A. Dracontium* are about 25 mm. in length by 22 mm. in width, but the greater number are smaller, some being only 6 mm. by 3 mm. The margin of nearly all leaves of *A. triphyllum* are very finely serrulate; while some leaves of *A. Dracontium* display a tendency to serrulation, more often they are entire. The upper surface of the *A. triphyllum* leaf is covered with faint whitish lines; this appearance is due to the presence of elongated raphide cells in the mesophyll directly beneath the epidermis. *A. Dracontium* has numerous raphide cells in the mesophyll but they are not so large as those of *A. triphyllum* and cannot be distinguished without the aid of the microscope. The under surface of the leaves of *A. triphyllum* is covered with a waxy bloom and the upper surface also shows some wax. In *A. Dracontium* the wax is very much thinner on the under surface and barely discernible on the upper. As a consequence the leaf of *A. Dracontium* wilts very quickly after being removed from the plant. The development of stomata on both leaves is about the same. The leaves of both species are pinnately net-veined. In *A. triphyllum* one pair of the lateral branches is more strongly marked than the others, foreshadowing distinctly the plan of the mature trifoliate leaf. In *A. Dracontium* the plan of venation is more generalized. The lateral veins have all equal value and are neither so well marked as some nor so faint as other lateral veins of the leaf of *A. triphyllum*. The mesophyll of the *A. Dracontium* leaf is not so well developed nor so well supplied with chlorophyll as is that of *A. triphyllum*. Those plumules of *A. Dracontium* which become assimilatory organs are functional for a shorter period than those of *A. triphyllum*, for they wither upon the plant much sooner. Those of longest duration last not more than three months while some send up

a petiole only, the blade being shriveled before it expands. Monstrosities seem to be very frequent in the leaves of *A. Dracontium*, for instance, the displacement of the mucronate point from the tip to the middle of the under surface of the midrib or the multiplication of these points upon the under surface. The blade is also often lobed upon one side and in one instance both sides of the leaf showed this peculiarity.

The petioles of the leaves of both species are streaked with red, the color being most abundant near the base. The petiole of *A. Dracontium* is considerably shorter than *A. triphyllum* and the fibro-vascular system is weaker on the whole although some stems of *A. Dracontium* and *A. triphyllum* show scarcely any difference. In the arrangement of tissue within the stem there is exact similarity. The bundles are arranged to form an open cylinder generally, in *A. Dracontium*, three on each side of the largest bundle. Those stems which attain the greatest development may have in addition a bundle running through the center of this cylinder, while in *A. triphyllum* the fibro-vascular system may include still another bundle, completing the cylinder and making nine bundles in all.

The development of the buds goes on during the growth of the seedling. Each rudimentary leaf arises as a hollow elevation enclosing the next youngest. At the end of the season the stem-bud of *A. Dracontium* has four bracts which enwrap the bud at the center and *A. triphyllum* agrees exactly with this plan in structure. All but the innermost of these enclosing bud leaves remain as rudiments upon the corm protecting the bud. The fourth grows large enough to protect the leaf as it pushes through the soil the second year, but remains at its base as a membraneous sheath.

The second season all *A. Dracontium* corms, like those of *A. triphyllum*, produce one trifoliolate leaf enclosed at the base by a sheath which, in those cases where no plumule is produced, must be regarded as the first leaf sent up by the plant. The functional leaf of the second season is trifoliolate normally, but is subject to great variation, such as the whole or partial fusion of two of its lobes or the complete obliteration of one of them. Even when the leaf is regularly trifoliolate great variations occur in the shape of

the individual leaflets. In some, the side leaflets may be narrowly lanceolate while others may approach an elliptical shape. The mid leaflet is generally broader than the lateral ones, but here too a variety of forms may occur. At the end of the second season's growth there is still a slight difference in the size of the corms of those plants of *A. Dracontium* which have borne a plumule the first year and those that have not. The root systems are, however, similar; six adventitious roots are developed in each. Except in the retarded development of its plumule, the development of the stem-bud of *A. Dracontium* agrees with that shown by *A. triphyllum*. The repression of the plumule does not seem to be correlated with any variations in the stem-bud of the second season, since variations of leaf form occur as frequently in second-year plants which produced a functional plumule the first season.

The principal differences between the seedlings of *A. Dracontium* and *A. triphyllum* consist not only in the reduction and variability of the roots, the variation and repression of the plumule on the part of *A. Dracontium*, but also in the precocious enlargement of the corm. This difference arises as soon as germination starts; in *A. Dracontium* the foodstuff of the endosperm is employed directly to build up the hypocotyl at the expense of the development of root and plumule. In *A. triphyllum*, however, as soon as the hypocotyl breaks through the seed coats, the roots are sent out and attain some development at once, the plumule then appears, and in normal cases it is only after this assimilatory organ is well established and the seedling has separated from the seed that the hypocotyl begins to enlarge. In *A. triphyllum* the endosperm furnishes the material which is necessary to bring the root and plumule to an advanced stage of development, and the food material for the hypocotyl is supplied by the assimilation of the plumule. The early enlargement of the corm and the repression of the plumule can scarcely be held to be due to a pathological condition of the seed or to an unfavorable environment, as the seeds planted were perfectly sound and the plumules in the embryos of those from the same lot which were examined showed no evidence of the attacks of parasites or any abnormality, while the conditions under which the plants were grown corresponded to the normal environment of these plants as was well demonstrated by

the vigorous growth of *A. triphyllum* which was subjected to the same conditions.

On the other hand the small proportion of functional plumules developed by seedlings of *A. Dracontium* and, in the cases in which a leaf was produced, the great variations in shape, the small size, the generalized form and venation, the delicacy of the lamina and the weak development of wax upon it, the shortness of the petiole and the frequent appearance of monstrosities, all are indications of degeneration and lead to the conclusion that this seedling is losing its power to produce a normal assimilating plumule. This conclusion is borne out by an examination of the internal structure. The petioles of the smaller leaves of *A. triphyllum* show the same arrangement of fibrovascular bundles as the largest of *A. Dracontium* and a series of increasingly smaller plumules which may easily be obtained from a number of seedlings shows a successively more generalized development of fibrovascular system until in the least developed system it becomes reduced to a mere rudiment. The highly organized fibrovascular system of the hypocotyl, which is of very little service to the seedling without a plumule and only a weakly developed root system, is still retained and bears evidence that the present type of seedling which brings a plumule to various stages of imperfect development may be a degeneration from a condition like that of the seedlings of *A. triphyllum* with a plumule normally functional.

So far as has been observed this type of germination is of no benefit to the seedlings. It does not seem to enable the corms to escape from the danger which they incur of being torn up by animals, for the development of the seedling without a strong root system of course precludes any great downward pull upon the corm by the contraction of its roots. Those plants of *A. Dracontium* which develop a leaf and correlated with this a stronger root system have invariably been found buried deeper than the plants whose plumule is not functional, for although in the plumuleless seedlings there is no upwardly directed force to bring the corm near the surface such as the plumule exerts in forcing its way through the ground yet on account of the weakness of the root system the tendency is such as to keep the corms very near the depth at which the seeds germinated. The repres-

sion of a plumule, of course, prevents the destruction of young seedlings by grazing animals; but the well-developed plumule contains enough raphide cells to protect it from attacks of this kind and the advantage which the plants enjoy in this respect is largely over-balanced by positive disadvantages. This variation, therefore, can scarcely have been perpetuated because of the advantage as a means of defense which plumuleless seedlings possess. As far as can be discovered at present this variation is of no benefit to the plant but, on the contrary, there are great disadvantages in this method of germination, which tend to throw the plant entirely upon the food supply of the parent form for another season.

The germination of *A. Dracontium* consists essentially in the conversion of the hypocotyl of the embryo into the corm of the seedling by the transfer of the food material contained in the endosperm. In some aroids,* this resorption of the endosperm and conversion of the base of the hypocotyl into a corm takes place before the embryo leaves the seed; that is to say, the development of the seed is not completed until a bulbiform embryo with true fibro-vascular bundles and no trace of cotyledon has been formed. An example of this type is *Spathyema foetida*. When the seed of this plant germinates the stem-bud pushes out of the micropyle and breaks through the ground first; later adventitious roots spring from the nodes. No primary root is produced. It will be seen that the only difference between the germination of this seed and the sprouting of the first year's corm of *A. Dracontium* is the fact that in the former case the seed coats which surround the bulbiform embryo must be penetrated by the stem-bud. If the corm formation of the seedling of *A. Dracontium* took place within the seed coats (and this could be brought about simply by the arrest of the elongation of the cotyledon) the two cases would be exactly similar. In fact the cotyledon of *A. Dracontium* is varying in just this direction, for it often displays a tendency to be shorter than the cotyledon of *A. triphyllum* as has been pointed out above. The delay in germination at first, moreover, may be another indication of a tendency to carry on the entire development of the corm within the seed.

* Engler. *Monographiae Phanerogamarum, Araceae*, II : 34.

Owing to the lack of time and material the development of the corm of *Spathyema* within the seed could not be traced but an examination of the literature of the subject brought out the fact that many aroids manifest a tendency to carry on the development of the plant as far as possible before actual germination, *i. e.*, emergence from the seed and development of assimilatory organs occurs.*

SUMMARY

The seeds of the two species present only a few unimportant differences in shape. In histological structure they are similar. The embryos are comparatively small and are imbedded in a copious farinaceous endosperm. The only essential distinction between them consists in the slightly greater amount of food material in the seed of *A. Dracontium*, the extra procambium strand of its cotyledon and the weaker development of procambium in the plumule of its resting embryo. The first stages of the germination of the two seeds are of the same character and consist in the emergence of the hypocotyl and stem-bud from the seed coats at the micropyle, by means of the elongation of the cotyledon.

As the development of the seedlings proceeds, the production of roots and a plumule takes precedence in *A. triphyllum* while in *A. Dracontium* the enlargement of the hypocotyl begins at once and the growth of the root and plumule is retarded. This precocious development of the corm often takes place to such a degree as to entirely inhibit the production of a functional plumule. The same differences between the two species in regard to the fibrovascular development is exhibited by the seedlings as is displayed by the resting embryo. The structure of the stem-bud which develops upon the corm during the first season's growth is absolutely the same in both species.

The seedling of *A. Dracontium* is diverging from what seems to be the normal type of germination in *Arisaema*, *i. e.*, the development of an assimilatory plumule and the production of a corm by means of the product of the photosynthetic activity of this organ, and is tending to produce a corm without the aid of a plumule by the direct transfer of the food material of the endosperm to the

* Engler. *Monographiae Phanerogamarum*. Araceae, 11 : 34, 35.

Griffith. *Trans. Linn. Soc.* 20 : 274-276. 1847.

hypocotyl. This type of germination does not seem to be due to a diseased condition of the seed or embryo or to an unfavorable environment nor does it appear to be advantageous to the young seedling. It might be suggested therefore that it is an expression of an inherent tendency in aroids to carry the young plantlet as far as possible in its development before an assimilatory organ is produced. If this conclusion be correct we have in *A. Dracontium* a transition stage between a seedling forming its corm outside of the seed coats with the aid of a plumule as in *A. triphyllum* and a corm formation within the seed coats at the expense of the endosperm as is the case with *Spathyema foetidus*.

Explanation of Plate 3

FIG. 1. Seedling of *A. Dracontium* showing hypocotyl just emerging from seed.

FIG. 2. Seedling of *A. Dracontium*. Hypocotyl has begun to enlarge, short root has appeared.

FIG. 3. Seedling of *A. Dracontium*. Root has elongated, root hairs have arisen.

FIG. 4. Seedling of *A. Dracontium*. Hypocotyl has enlarged greatly, first root has elongated, second root is just appearing.

FIG. 5. Seedling of *A. Dracontium*. Hypocotyl has attained full size of first year's corm.

FIG. 6. Seedling of *A. Dracontium*. Specimen in which the root system has been only slightly developed.

FIG. 7. First-year corm of *A. Dracontium*. Formation of periderm at base of cotyledon has separated corm from seed.

FIG. 8. Seedling of *A. Dracontium* which has produced plumule.

FIG. 9. Seedling of *A. Dracontium*. More advanced; note single contractile root, developed only in those cases where plumule is sent up.

FIGS. 10, 11, 12. Variations in form of plumule in those seedlings of *A. Dracontium* which send up a leaf.

FIGS. 13, 14. Second-year leaves of *A. Dracontium* when a plumule had been developed by seedling.

FIGS. 15, 16, 17, 18, 19. First leaves produced by *A. Dracontium* corms which have been developed without the aid of a plumule.

FIG. 20. Seedling of *A. triphyllum*. Hypocotyl just emerging.

FIG. 21. Seedling of *A. triphyllum*. Cotyledon lengthened, hypocotyl has begun to enlarge, root has arisen.

FIG. 22. Seedling of *A. triphyllum*. Second root appearing.

FIG. 23. Seedling of *A. triphyllum*. Second root has increased in length.

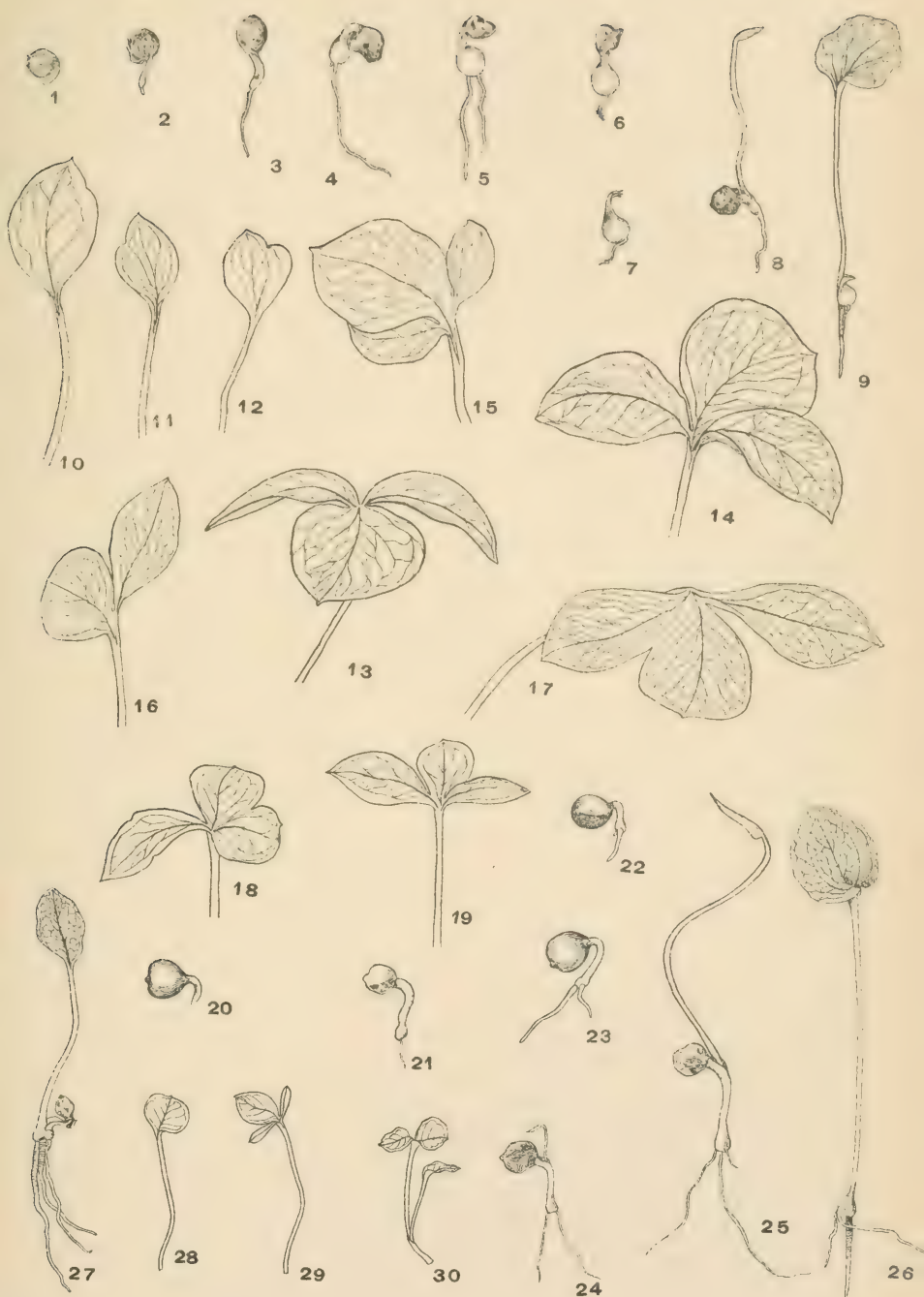
FIG. 24. Seedling of *A. triphyllum*. Plumule has emerged from cotyledonary sheath.

FIG. 25. Seedling of *A. triphyllum*. Petiole of plumule has lengthened, a third root has appeared. Hypocotyl perceptibly enlarged.

FIG. 26. Seedling of *A. triphyllum*. Contractile root formed, plumule fully expanded.

FIG. 27. Seedling of *A. hybrida*. Plumule produced.

FIGS. 28, 29, 30. Variations in form of leaf produced second year by *A. hybrida*.



CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 21

TWO NEW WESTERN MOSSES

BY R. S. WILLIAMS.

NEW YORK

1902

[Reprinted from BULLETIN TORREY BOTANICAL CLUB, 29: 66-68. 25 Feb., 1902].

Two new Western Mosses

BY R. S. WILLIAMS

(WITH PLATES 4 AND 5)

Eurhynchium Taylorae

Evidently dioicous; no ♂ flowers found. In loose tufts with stout, creeping stems (in places denuded of leaves and with dense tufts of radicles) up to 20 cm. long and 0.44 mm. in diameter; cross sections show a well-defined central strand of numerous small cells and outer wall of about three rows of small thick-walled cells; branches rather short (1 to 2 cm.), irregular and often distant; stem and larger branch leaves loosely spreading, obtusely pointed, the branch leaves often truncate or praemorse at tip, decurrent, serrulate all round to a little above the base, reflexed on margin above and near base and costate about $\frac{7}{8}$ up, the costa ending in spine and more or less papillose below; stem leaves measure up to 2.5×1.5 mm., middle branch leaves 1.5 mm. and upper branch leaves 0.875 mm. long, the lowest branch leaves very small, roundish and often ecostate; inner perichaetial leaves ecostate or very faintly costate, abruptly narrowed to a slender flexuous serrulate point and irregularly toothed and lacerate at base of point; leaf-cells mostly linear-vermicular, median $.004 \times .06$ to $.08$ mm., apical very short and irregular, alar forming an elongated not well-defined group of pale cells about $.008$ mm. wide and two to four times longer, the basal cells somewhat thickened and pitted, especially toward costa; capsule mostly horizontal, contracted more or less under the mouth when dry, without lid 2.5 by 1.5 mm., lid with obliquely rostrate beak 2 mm. long, stout, smooth seta up to 15 mm. high, annulus of two or three rows of cells; peristome teeth very slender-pointed, striate below, papillose above, hyaline bordered, the segments more or less split with mostly two somewhat appendiculate cilia between; stomata roundish, $.025$ mm. in diameter; spores nearly smooth, up to $.014$ mm.

In size this plant most nearly approaches *E. Oregonum* of any of our North American species but is less regularly pinnate with smooth seta, etc. It much more closely resembles *E. striatum* of Europe, but is a more creeping plant with less divided stems and leaves never acutely pointed as in that, which also lacks the spine at apex of costa.

Collected by J. B. Leiberg on decaying logs in streams, April, 1889, Traille River Basin, Idaho (172). Named for the artist who has made the excellent drawing which accompanies this description, Miss Alexandrina Taylor.

Brachythecium Pringlei

Monoicous; ♂ flowers abundant on fruiting stems. Growing in compact tufts with ascending, more or less branching stems 4–5 cm. long and 0.25 mm. in diameter; cross sections of stem show a distinct central strand and 3 or 4 rows of thick-walled outer cells; branches mostly short, rather irregular, with curved tips; stems and branch leaves very similar, up to 2.5×1.5 mm., secund, mostly broadly ovate with short acute point, long decurrent, concave, scarcely or not plicate, borders flat, entire or slightly serrulate above; leaf-cells somewhat thickened and near base, pitted; median cells linear, about $.04 \times .005$ mm., alar cells mostly about $.012 \times .016$ mm., often forming a distinct convex cluster packed with chlorophyll; inner perichaetial leaves erect, gradually lanceolate-pointed, the point somewhat variable in width, nearly entire and ecostate; seta distinctly papillose in upper part, about 1 cm. high; capsules (not quite mature in only specimens seen) ovate-oblong, not quite symmetrical, nearly erect, with lid 2.5 mm. long; lid highly conical, .8 mm. high; annulus narrow, of 1 or 2 rows of cells; teeth about .430 mm. high and .065 mm. wide at base, rather broadly and irregularly pointed, hyaline bordered, rather irregularly striate and somewhat papillose below, and distinctly papillose above; basilar membrane of endostome extending about two fifth up, segments more or less split, cilia mostly 2 and not appendiculate; stomata slightly elongated, about .025 mm. long; spores (immature) smooth, .015 mm.

This plant with its short-pointed, scarcely plicate and secund leaves with vein sometimes forking, has much the appearance of a *Limnobium* (*Hygrohypnum*), but the seta rough above and the highly conical lid seem to relate it most closely to *Brachythecium*, which also contains all the first-mentioned characters. Collected by C. G. Pringle in the Huachuca Mts., Arizona, July, 1884 (22).

Explanation of Plates

Drawings made with a magnification twice the diameter reproduced on the plates.

PLATE 4

FIG. 1. Plant, natural size.

FIG. 2. Stem leaf, $\times 15$.

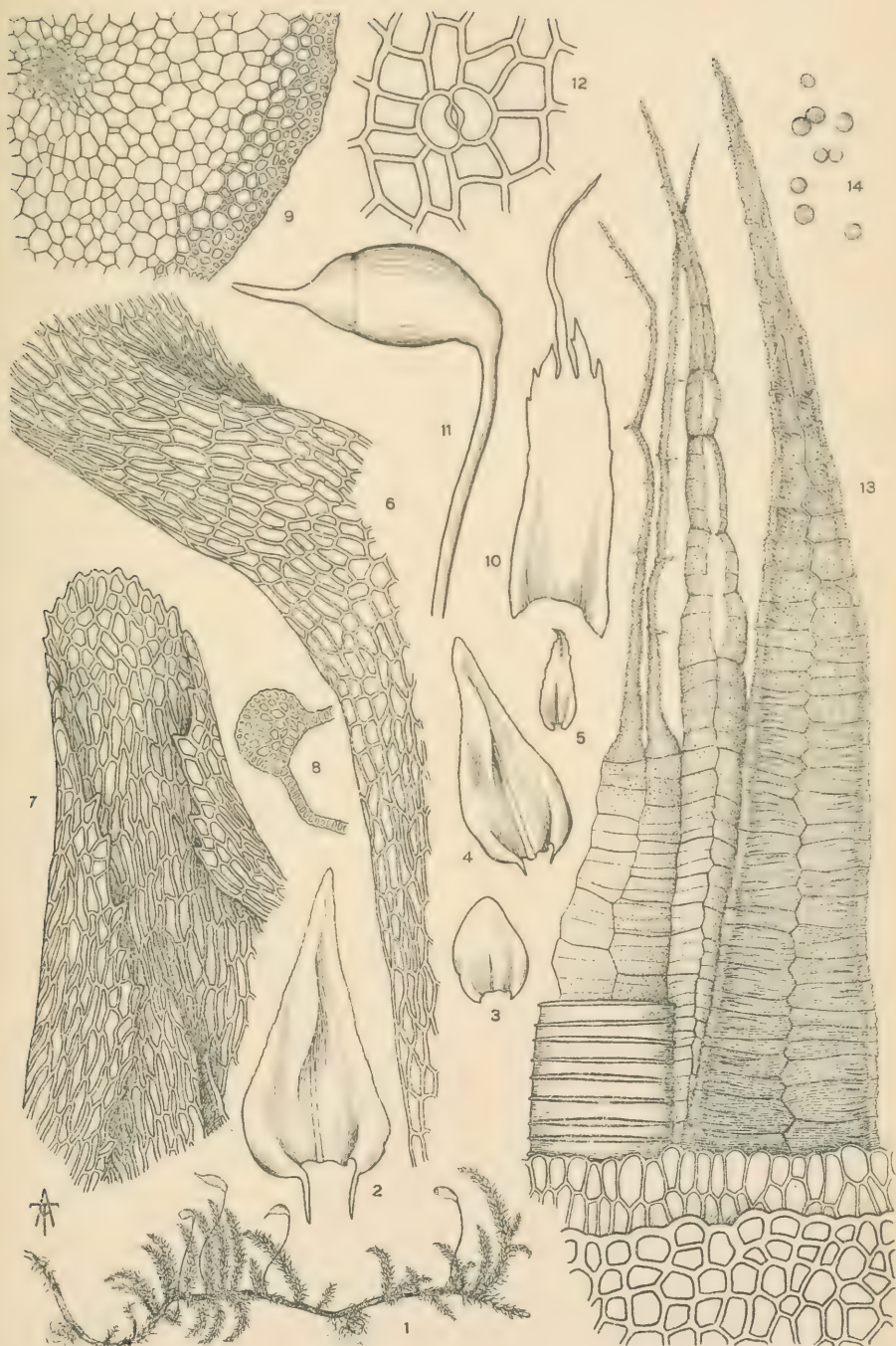
FIGS. 3, 4, 5. Lower, middle and upper branch leaf, $\times 15$.

FIG. 6. Alar leaf of stem leaf, $\times 120$.

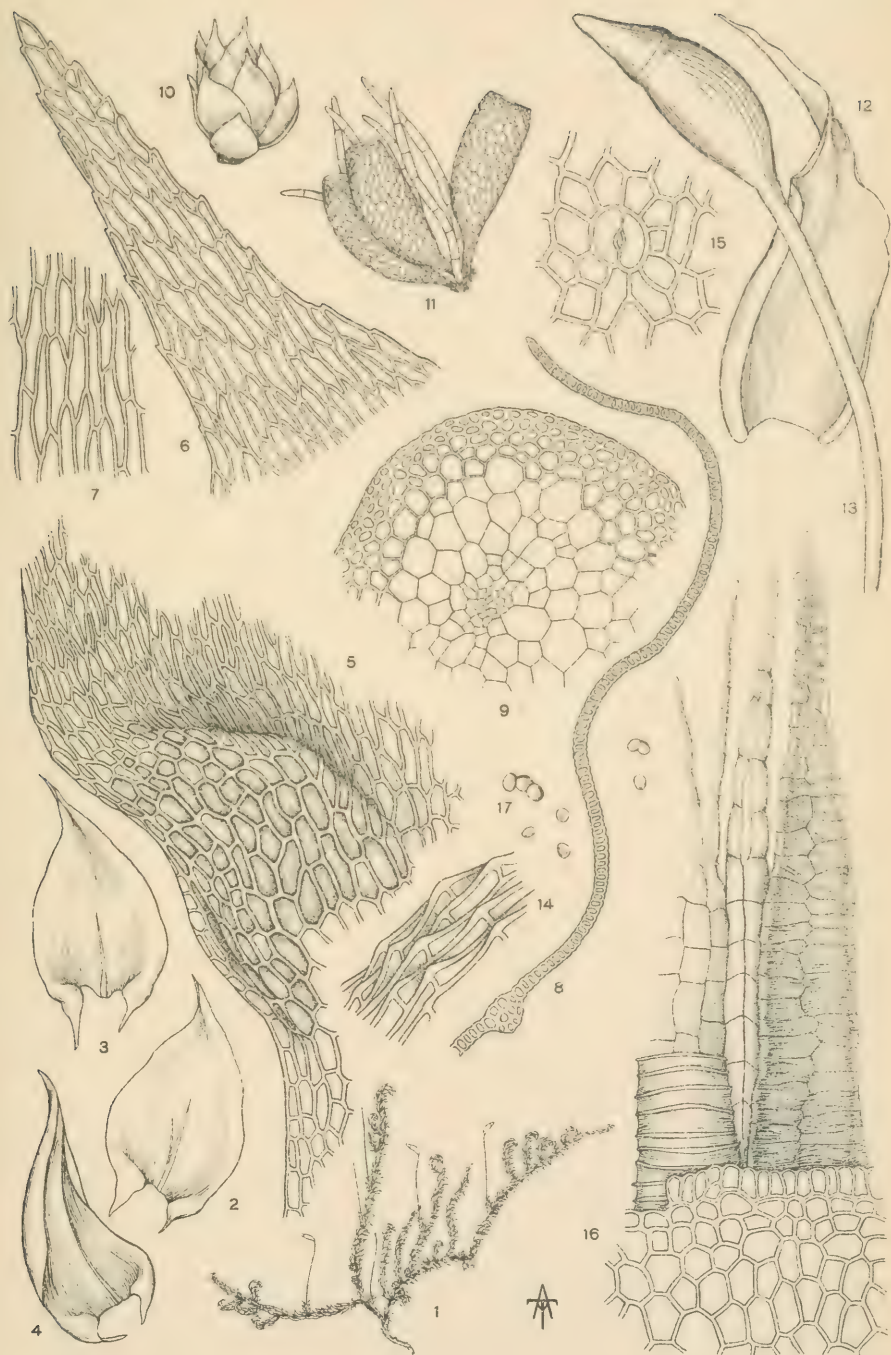
- FIG. 7. Apex of same, $\times 120$.
FIG. 8. Cross section of costa.
FIG. 9. Part of cross section of stem, $\times 87$.
FIG. 10. Perichaetial leaf, $\times 15$.
FIG. 11. Capsule, $\times 7.5$.
FIG. 12. Stoma, $\times 210$.
FIG. 13. Portion of peristome with annulus, $\times 120$.
FIG. 14. Spores, $\times 120$.

PLATE 5

- FIG. 1. Plant, natural size.
FIG. 2, 3. Stem leaves, $\times 15$.
FIG. 4. Branch leaf, $\times 15$.
FIG. 5. Alar region of stem leaf, $\times 120$.
FIG. 6. Apex of same, $\times 120$.
FIG. 7. Median cells, $\times 210$.
FIG. 8. Cross section of leaf, $\times 120$.
FIG. 9. Part of cross section of stem, $\times 120$.
FIG. 10. Antheridial bud, $\times 15$.
FIG. 11. Antheridia and paraphyses, $\times 45$.
FIG. 12. Perichaetial leaf, $\times 17$.
FIG. 13. Capsule with upper part of seta.
FIG. 14. Oblique view of seta showing papillae, $\times 162$.
FIG. 15. Stoma, $\times 210$.
FIG. 16. Part of peristome and capsule, $\times 120$.
FIG. 17. Spores, $\times 120$.



EURHYNCHIUM TAYLORAE



BRACHYTHECIUM PRINGLEI

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 22

STUDIES ON THE ROCKY MOUNTAIN FLORA
VII.

BY PER AXEL RYDBERG.

NEW YORK

1902

[Reprinted from BULLETIN TORREY BOTANICAL CLUB, 29: 145-160. 24 March, 1902].

Studies on the Rocky Mountain Flora—VII

BY PER AXEL RYDBERG

Aquilegia Columbiana

Perennial with a short thick rootstock : stem 6–10 dm. high, glabrous or sparingly and finely pubescent above ; basal leaves twice ternate ; petioles 1–2 dm. long ; segments rounded, obovate, 2–3 cm. long, more or less glaucous beneath, 2–3-cleft and deeply crenate at the apex ; lower stem-leaves similar to the basal leaves, but with short winged petioles, the upper similar but often with larger segments : sepals and spurs very bright red ; laminae yellowish : sepals ovate-lanceolate, acute, 15–25 mm. long, exceeding the spur, widely spreading or reflexed : lamina very short, scarcely 3 mm. long, truncate ; spur 12–18 mm. long, thick, abruptly contracted about the middle : follicles erect, densely pubescent ; styles about 12 mm. long.

This species is somewhat intermediate between *A. formosa* and *A. truncata* and has been mistaken for both. It has the habit, the spur and sepals of the former and the short truncate lamina of the latter.

WASHINGTON : Montesano, 1898, *A. A. & E. Gertrude Heller*, 3936 (type in herb. N. Y. Bot. Garden) ; upper valley of the Nesqually, 1896, *O. D. Allen*, 249 ; 1889, *G. R. Vasey*, 150 ; Humptulips, 1895, *F. H. Lamb*, 1180 ; Puget Sound, *Wilkes Exped.*, 646.

BRITISH COLUMBIA : Banff, 1897, *Zoe W. Palmer*.

ALASKA : Short Bay, 1895, *Gorman*, 105 ; Disenchantment Bay, 1892, *F. Funston*, 121.

IDAHO : Florida Mt., 1892, *A. Isabel Mulford*.

Aquilegia thalictrifolia

Perennial with a short rootstock : basal leaves twice ternate ; petioles 1–2 dm. long ; segments broadly obovate-cuneate, 2–3-cleft and crenate at the apex, 1–1.5 cm. long, bluish-green : stem 2–5 dm. high, glabrous below, finely viscid puberulent above : stem-leaves sessile or very short-petioled, otherwise similar to the basal ones : flowers yellow : sepals 10–18 mm. long, ovate to ovate-lanceolate, acute : laminae of the petals 7–12 mm. long, truncate or rarely rounded at the apex ; spur very slender from

the base, 4-5 cm. long : follicles without the styles, about 3 cm. long and 5 mm. wide, strongly reticulate and pubescent, strongly curved above.

This species is nearest related to *A. chrysantha* with which it has been confused, but differs in the smaller flowers, blunter sepals, smaller and bluer segments of the leaves and the more curved follicles. It grows at an altitude of 1500-3000 m.

COLORADO : Cañon City, 1873, *E. L. Greene* (type in herb. Columbia University); Colorado Springs, 1893, *De Alton Saunders*; Grand Cañon of the Arkansas, 1873, *Brandegee*; Bear Creek Cañon, 1892, *C. S. Sheldon*.

TEXAS : West Texas, 1888, *Nealley*.

ARIZONA : Mt. Humphrey, 1897, *R. E. Kunze*.

Aquilegia Eastwoodiae

Aquilegia ecalcarata Eastwood, *Zoe*, 2 : 226. 1891. Not Hortul.; Steudel. 1841.

This has been regarded as a spurless form of *A. micrantha* Eastw., but the form of the terminal segments of the leaves is different from any American species, being rhombic in outline and acute.

Aquilegia oreophila

Aquilegia coerulca alpina A. Nelson, First Rep. Fl. Wyo. 78. 1896. Not *A. alpina* L. 1853; *Aquilegia coerulca* var. *flavescens* Jones, Cont. West. Bot. 8 : 2. 1898. Not *A. flavescens* Wats. 1871.

This is evidently what Jones regards as *A. flavescens* Wats., but is not Watson's species, for he describes the spur as being curved. Specimens of both numbers cited by Watson, viz. 35 and 36, are in the Columbia University herbarium and these as well as the plant cultivated under the name *A. flavescens* at Harvard have curved spurs and can not be referred as a variety to *A. coerulca*. Therefore, I can not see why Mr. Jones' *A. depauperata* should not pass into synonymy, being the same as the true *A. flavescens*. The flowers of *A. oreophila* resemble most those of *A. pubescens* Coville, but the habit is different and nearer *A. coerulca*.

Delphinium alpestre

A low caespitose perennial : stems several, about 1 dm. high, puberulent and viscid above, densely leafy ; leaves digitately di-

vided into about 5 divisions, finely and sparingly puberulent when young, dark green; petioles 4-5 cm. long; divisions of the blades 1.5-2 cm. long, cuneate-obovate in outline, divided half-way into oblong mucronate lobes; inflorescence short and few-flowered; pedicels ascending, 1 cm. or less long, viscid; bractlets minute; sepals dark blue, oblong, obtuse or the upper acute, viscid-puberulent; spur 8-9 mm. long; upper petals blue and yellowish, 2-toothed at the apex; lateral petals 2-cleft; lobes lanceolate; follicles not seen.

This is not closely related to any of the American species. It has the caespitose habit of *D. glaucescens*, but is a much smaller plant. It grows among rocks at an altitude of 3300 m. or more.

COLORADO: Mountains northwest of Como, 1895, *Crandall & Cowen*, 1848 (type in herb. State Agric. Coll., Colo.); West Spanish Peak, 1900, *Rydberg & Vreeland*, 6218.

Delphinium multiflorum

A tall perennial with a woody caudex; stem about 1 mm. high or more, viscid above, glabrate below; leaves palmately divided into 5-7 divisions, glabrous and glaucous, pubescent only on the margins and veins; petioles 1-2 dm. long, slightly dilated at the base; segments obovate-cuneate in outline, 5-7 cm. long, first cleft about half-way and then again cleft into lanceolate, ovate or oblong acute lobes; inflorescence long and dense, often branched; bracts linear; pedicels ascending, 1-1.5 cm. long, densely viscid-pubescent; bractlets small, linear, close under the calyx; sepals light blue with darker median lines or blotches towards the tips, oblong-oval, obtuse or the upper acutish, finely puberulent; spur thick, straight or slightly curved, 12-15 mm. long, almost horizontal; petals of the same color as the sepals; the lateral ones cleft only at the apex, often wavy-toothed; follicles erect, densely viscid-pubescent.

This is nearest related to *D. cuculatum* A. Nelson on one hand and to *D. occidentale* on the other. From the former it differs in the pubescence, which in *D. cuculatum* is strigose, in *D. multiflorum* viscid. *D. occidentale* has much darker flowers and more acute sepals. *D. multiflorum* grows along streams and in damp meadows or open woods at an altitude of 2000-2500 m.

WYOMING: Spread Creek, 1897, *F. Tweedy*, 179 (type in herb. N. Y. Bot. Gard.); Yellowstone Lake, 1888, *R. S. Williams*; Laramie Mountains, 1899, *Charles Schuchert*; between Upper

Buffalo Fork and Du Noir River, 1899, *C. C. Curtis*; Snake River, 1899, *Aven & Elias Nelson*, 6407.

IDAHO : Henry's Lake, 1897, *Rydberg & Bessey*, 4079.

COLORADO : North Park, 1896, *C. F. Baker*.

Delphinium Brownii

Perennial : stem about 1 m. high, glabrous and shining throughout, simple : leaves palmately divided into about 5 divisions, puberulent ; lower petioles 8-10 cm. long ; divisions 4-6 cm. long, oblanceolate in outline, once to twice cleft into lanceolate, acute, somewhat spreading lobes : inflorescence a rather lax raceme ; bracts linear ; pedicels slender, 1-2 cm. long, almost erect, curved and twisted ; upper portion sometimes slightly puberulent ; bractlets linear-subulate, small, 3-4 mm. long : sepals dark blue or purple, oblong-oval, obtuse or the lower and upper acutish, 10-12 mm. long : lateral petals also blue or purplish ; blade cleft only about one third its length ; upper petals of the same color or paler, obliquely cuneate, acute ; spur short and rather thick, 1 cm. or less long, straight and ascending : follicles erect, glabrous.

This is nearest related to *D. glaucum*, but differs in the puberulent leaves with narrower segments, the lax raceme with more erect pedicels and the darker flowers.

ALBERTA : Banff, 1893, *Addison Brown* (type in herb. Columbia University).

ALASKA : Porcupine River, 1891, *J. H. Turner*.

Delphinium elongatum

Tall perennial with a short woody caudex : stem glabrous and glaucous up to the inflorescence, which is slightly strigose : leaves digitately divided into about 7 divisions, glabrous and glaucous beneath ; petioles fully 1 dm. long ; divisions of the blade oblanceolate in outline, 5-7 cm. long, cleft into lanceolate, acute lobes : inflorescence strict and elongated ; bracts small, linear, almost filiform ; pedicels 1-2 cm. long, at first ascending, in fruit almost erect ; bractlets minute, subulate : sepals and petals dark blue, the former oval, obtuse or acutish, about 1 cm. long ; spur short, straight, about 12 mm. long : lateral petals cleft at the apex, more or less toothed : follicles erect, 12-15 mm. long, strigose-puberulent.

In some respects nearest to *D. glaucum*, but differing in the puberulent pod, strigose pubescence at least on the pedicels, and the narrower divisions and lobes of the leaves. It grows at an altitude of about 2000 m.

COLORADO: Larimer county, 1895, *Crandall & Cowen*, 15 (type in herb. N. Y. Bot. Garden); Villa Grove, 1896, *F. Clements*, 338; Middle Park, 1861, *C. C. Parry*, 85; Baxton's Ranch, 1890, *Crandall*, 1547.

MONTANA: Lima, 1895, *Rydberg*.

Delphinium diversicolor

Perennial with a thick fleshy root, the branches of which are often fusiform: stem about 4 dm. high, simple, strict, densely viscid-pubescent above: leaves finely pubescent, palmately dissected into linear lobes; petioles of the lower leaves 3-5 cm. long, slightly dilated below; segments 1-3 cm. long, about 2 mm. wide: inflorescence a narrow raceme; pedicels .5-1 cm. long, or in fruit 1.5 cm., densely viscid, almost erect: sepals dark blue, oblong-oval, obtuse, 10-13 mm. long, slightly pubescent; spur almost straight, horizontal: petals all white with blue veins and yellowish below; the upper about 5 mm. long, obliquely spatulate, obtuse; the lateral ones slightly longer, curved; the blades deeply 2-cleft; each lobe of the form of one third of a circle: follicles densely hairy.

This species is perhaps nearest related to *D. simplex* and *D. Burkei*. From the former, it differs in white lateral petals and the pubescent leaves, and the latter is described as subscapose. The type was collected in a bog, at an altitude of 2000 m.

MONTANA: Rattlesnake Creek, Beaver Head county, 1887, *Frank Tweedy*, 34 (type in herb. Columbia University).

Aconitum tenue

Perennial with small tubers about 8 mm. long and 4 mm. thick: stem very slender, about 3 dm. high: leaves few; the lower with petioles 5-8 cm. long, the uppermost subsessile: blades glabrous, thin, shining, almost pentagonal in outline, 5-7-divided to near the base; divisions rhombic in outline, 3-cleft and the lobes often again cleft, the ultimate divisions oblong-linear to linear-lanceolate, acute: inflorescence racemose, 2-6-flowered: pedicels erect and bent near the glabrous blue calyx: hood 15-18 mm. long, boat-shaped, slightly saccate, almost semicircular in outline; lateral sepals rounded ovate, only slightly oblique, 10-12 mm. long; lower sepals oblong, obtuse at the apex, 8-10 mm. long: fruit unknown.

The type was collected in a damp cañon among rocks at an altitude of about 2000 m. It is perhaps nearest related to the Alaskan *A. delphinifolium*.

SOUTH DAKOTA: Sylvan Lake, Black Hills, 1892, *P. A. Rydberg*, 507 (type in herb. Columbia University).

Aconitum atrocyaneum

Perennial with thickened-fusiform roots: stem stout, 4–6 dm. high, leafy, glabrous below, densely glandular viscid and purplish above: lower leaves with petioles 5–10 cm. long; blades about 6 cm. wide, glabrous, pentagonal in outline, 5–7-divided to near the base; divisions rhombic-cuneate to oblanceolate, usually twice cleft; ultimate segments lanceolate acute; upper stem-leaves similar but with short petioles or those of the inflorescence lanceolate, toothed and often with recurved basal lobes: inflorescence racemose, many-flowered, leafy: pedicels 1–3 cm. long, erect, very viscid: flowers dark indigo blue, more or less pubescent: hood deeply saccate, helmet-shaped, about 18 mm. long, with the front line more or less concave: beak somewhat porrect, acuminate, the lower margins nearly horizontal: lateral sepals broadly rounded-ovate, somewhat oblique, 12–15 mm. long: lower sepals 9–12 mm. long, oblong, obtuse.

This species is perhaps closest related to *A. ramosum* A. Nelson, but the divisions of the leaves are broader and the hoods are different, having a porrect beak, while in *A. ramosum* the beak is short and directed downward. The flowers are also darker and the inflorescence more viscid. It grows at an attitude of 2,500–3,400 m.

COLORADO: Boreas, 1897, *C. S. Crandall* (type in herb. N. Y. Bot. Garden; cotypes in herb. State Agric. College, Colo.); mountains about Steamboat Springs, 1891, *C. S. Crandall*; near Ironton, 1899, *C. C. Curtis*; Cameron Pass, 1896, *C. F. Baker*.

UTAH: Uinta Mountains, 1873, *T. C. Porter*.

Aconitum porrectum

Perennial with thick fusiform roots: stem stout, 6–7 dm. high, leafy, glabrous below, densely viscid-pubescent above; basal leaves glabrous, with petioles about 1 dm. long; blades reniform-pentagonal in outline, 6–10 cm. wide, 5–7-divided to near the base; divisions rhombic or rhombic-oblanceolate, variously cleft above, cuneate at the base: inflorescence racemose or somewhat paniculate, not leafy: pedicels ascending, 1–3 cm. long: sepals dark blue, ciliate on the margins; hood very saccate, helmet-shaped; beak acuminate, porrect, horizontal or even slightly ascending, 15–18 mm. long; lateral sepals broadly obovate or semi-reniform,

about 12-14 mm. long, very oblique; lower sepals lanceolate or oblong, acute, 7-10 mm. long.

This is closely related to the preceding, but differs in the broader and less deeply divided divisions of the leaves, the shorter lower sepals, the more open and less leafy inflorescence, and the more oblique lateral sepals. It grows at an altitude of 2400-2800 m.

COLORADO: Coffee Pot Spring, 1894, *Crandall* (type in herb. N. Y. Bot. Garden; cotypes in herb. State Agric. College, Colo.); Graymount, 1892, *Crandall*; foothills, Larimer county, 1895, *Crandall & Cowen*; Arapahoe Pass, 1891, *Crandall*, 26; Lake City, 1881, *J. S. Neaberry*; North Park, near Teller, 1884, *C. S. Sheldon*.

Aconitum glaberrimum

Perennial with a tap root: stem almost 1 m. high, perfectly glabrous; leaves 5-divided, thin, perfectly glabrous, the lower long-petioled; the uppermost subsessile; divisions oblanceolate to rhombic-oblanceolate in outline, 5-10 cm. long, cuneate and entire at the base, irregularly doubly cleft above; lobes or teeth lanceolate, acute or acuminate; inflorescence compound; branches and pedicels spreading or divergent, glabrous; flowers blue; lower sepals lanceolate, 12-15 mm. long; lateral ones very oblique, as broad as long, about 15 mm. each way, rounded, slightly reniform on the upper side; hood about 2 cm. long, deeply saccate, elongated helmet-shaped; beak long-attenuate, very porrect or even ascending.

The type specimen was included in *A. Columbianum* by Dr. Gray, his "Syn. Fl. N. Amer." label being on the sheet; but it is so unlike all other material of that species that I can not see the reason why it should be included therein. The perfectly glabrous stem, the branched inflorescence, the peculiar, deeply saccate hood and the slender porrect beak are characters not found in any other American aconite.

SOUTHERN UTAH, NORTHERN ARIZONA: 1877, *Dr. E. Palmer*, 11 (type in herb. Columbia University).

Anemone tuberosa

Anemone sphenophylla Britton, Ann. N. Y. Acad. 6: 224, in part. Not Poepp. 1827-29.

Perennial with a thick tuberous root, basal leaves with petioles

about 5 cm. long, twice ternate ; divisions rhombic-cuneate in outline, ternately cleft and toothed ; teeth oblong-ovate : scape 1-3 dm. high, perfectly glabrous below the involucre ; peduncles finely appressed silky ; involucral leaves similar to the basal ones, but short-petioled and with longer lobes and teeth ; peduncle solitary or a second one with a smaller involucre : sepals white or purplish, 8-10, oblong-linear, 1-2 cm. long, finely silky : head of fruit ellipsoid, about 1 cm. thick and 2 cm. long : achenes densely woolly : style filiform, about 1.5 mm. long.

This is closely related to *A. sphenophylla* of Chili, but in that species the whole scape is decidedly pubescent with spreading hairs and the segments of the involucral leaves are narrower. The following species belong here :

ARIZONA : Sierra Tuscon, 1884, *C. G. Pringle* (type in herb. Columbia University) ; Fort Huachuca, 1892, *S. E. Wilcox*.

NEW MEXICO : Mountain near Las Cruces, 1895, *E. O. Wooton*.

UTAH : St. George, 1880, *M. E. Jones*, 1607.

CALIFORNIA : Panamint Mountains, 1891, *Coville & Funston*, 500 ; 1849 (locality not given), *Fremont*.

Anemone lithophila

Perennial with a short thick rootstock : basal leaves several, glabrous or nearly so, thickish, shining, somewhat glaucous ; petioles 5-8 cm. long ; blades ternate ; divisions obovate-cuneate, about 3 cm. long, strongly veined, deeply 3-cleft, again cleft and toothed ; the ultimate segments short, oblong-oblancheolate : scape 1-2 dm. high, sparingly pubescent with long silky hairs : involucral leaves subsessile or short-petioled ; divisions similar to those of the basal leaves : sepals silky, ochroleucous, tinged with blue, 12-15 mm. long, broadly obovate or oval : achenes densely villous all over : style filiform, about 2 mm. long.

The type was growing with *A. parviflora* at an altitude of 1800 m. As none of the specimens there had well-developed fruit and the plant is intermediate between *A. parviflora* and *A. globosa* Nutt., which also grew in the neighborhood, this species may be a hybrid. The strong veins and shiny glaucous leaves suggest the former but the general leaf-form the latter, although the segments are broader and shorter and the leaves more glabrate. Watson's specimen, which resembles the type perfectly has fully developed fruit, however. The type was labelled *A. Tetonensis*,

which it resembles most in habit ; but the achenes are woolly all over, not merely strigose on the back as in that species and the flowers are larger and lighter. The following specimens are to be referred here :

MONTANA : Little Belt Mountains, nine miles from Barker, 1896, *J. H. Fledman*, 459 (type in herb. N. Y. Bot. Garden), and 463 ; Lake Stanton, 1894, *R. S. Williams*.

UTAH : Uinta Mts., 1869, *S. Watson*, 10.

Anemone Piperi Britton

Perennial with a rather slender rootstock : stem 1.5–3 dm. high, slender, very sparingly appressed silky ; basal leaves ternate, minutely appressed-puberulent when young, in age glabrous ; petioles 1–2 dm. long ; middle lobe rhombic-obovate or rhombic-cuneate, coarsely toothed above the middle, 2–7 cm. long ; the lateral ones broader, obliquely ovate, 2-cleft to about the middle, coarsely toothed : involucreal leaves similar, but the lobes usually narrower : petioles 1–3 mm. long : pedicel 2–5 cm. long, erect in fruit, sparingly appressed silky : sepals elliptic-obovate to oval, about 15 mm. long, 6–8 mm. wide, white, glabrous : achenes about 4 mm. long, densely short-pubescent, ellipsoid, slightly compressed, tapering to both ends : beak very short.

This has been included in *A. quinquefolia* and all specimens cited for that species from the Northwest may belong here. It differs, however, from that species in the form of the basal leaves, the erect pedicels and the short, almost straight beaks of the achenes.

IDAHO : Latah county, 1893, *C. V. Piper*, 1469 (type in herb. Columbia University) ; Craig Mountain, 1892, *Sandberg*, *MacDougal & Heller*, 194.

WASHINGTON : Kamiac Butte, 1896, *A. D. E. Elmer*, 393.

Clematis Jonesii (Kuntze)

Clematis Douglasii var. *Jonesii* Kuntze, Verh. Bot. Ver. Brandenburg, 26 : 180. 1886.

Perennial with a thick rootstock or caudex : stems 3–6 dm. high, simple or later in the season branched, more or less woolly when young : leaves twice pinnately divided, 1–1.5 dm. long, villous when young, in age glabrate, rather firm, segments lanceolate to linear-lanceolate, often cleft, 1–5 cm. long, acutish : flowers nod-

ding : calyx campanulate, brown, more or less villous, especially near the margins ; sepals 2-2.5 cm. long, ovate, acute or acuminate, upper half with a wavy dilated margin : achenes about 5 mm. long and 4 mm. wide, flattish, densely silky ; tails of the achenes 4-5 cm. long, beautifully plumose throughout.

This is nearest related to *C. Douglasii*, with which it has been confused. It differs from that species in the dilated margins of the sepals, the distinctly petioled and less compound leaves. In the true *C. Douglasii* the upper and middle leaves are twice pinnately divided and subsessile, so that they with the first pair of primary divisions look as if verticillate. Kuntze's description of *C. Douglasii* var. *Jonesii* is so meager that nobody could know from it what he meant, but fortunately we have one of Jones' specimens. The following specimens belong to *C. Jonesii*.

COLORADO : Howe's Gulch, 1899, *W. F. M.* ; Dolores (7300 ft.), 1892, *Crandall* ; lat. 39°-41°, 1862, *Hall & Harbour*, 2 ; Howe's Gulch, 1893, *C. F. Baker* ; near Boulder, 1892, *H. M. Patterson*, 168 ; Dixon Cañon, 1891, *J. H. Cowen*, 368.

UTAH : Uinta Mountains, 1869, *S. Watson*, 1 ; American Fork, 1880, *M. E. Jones*, 1351.

WYOMING : Headwater of Tongue River, Big Horn Mountains, 1898, *Frank Tweedy*, 171.

Clematis eriophora

Perennial, from a woody caudex : stems and leaves prominently white-villous, the former 3-5 dm. high, simple : leaves 5-10 cm. long, distinctly petioled, twice pinnately divided ; ultimate segments narrowly linear, 1-3 cm. long, 1-2 mm. wide : flowers nodding ; calyx villous, campanulate, about 3 cm. long ; sepals oblong, obtuse, the upper third spreading, with a dilated margin : achenes oblong, about 6 mm. long and 3 mm. wide, silky, with a blunt ridge on each side ; tails about 4 cm., beautifully plumose.

This is closely related to the preceding and to *C. Bakeri*, but differs from the former in the narrower leaf-segments, the obtuse and thicker sepals and the denser and more persistent pubescence, and from the latter in the longer leaf segments and the obtuse dilated sepals. It grows at an altitude of 1500-2000 m.

COLORADO : Vicinity of Horsetooth, 1896, *J. H. Cowen* (type in herb. N. Y. Bot. Garden ; cotypes in herb. State Agric. College, Colo.) ; Foothills, Larimer county, 1893, *C. S. Crandall* ; Colorado,

1870, Dr. G. W. Hulse; 1844, Fremont, 567; Pagosa, 1883, Brandegee; Golden City, 1871, E. L. Greene; Clear Creek, 1873, John Wolf, 92; Colorado Springs, 1900, Rydberg & Ireland, 6232; Rist Cañon, 1890, Crandall, 272; 1893, 1379; Horse-tooth Gulch, 1898, Crandall.

CLEMATIS WYETHII Nutt. Journ. Acad. Phila. 7: 6 1834

I think that this species is distinct from *C. Douglasii* Hook., the leaves being never twice pinnately divided, having much broader segments and never being falsely verticillate as in that species. The specimens from Beaver Cañon, Idaho, cited in the synoptical flora under *C. Douglasii* var. *Scottii* and in Howell's flora of the Northwest under *C. Scottii* belongs undoubtedly here. A broad-leaved *C. Wyethii* and a narrow-leaved *C. Scottii* resemble each other very much and can be distinguished only by the flower, which in the former is campanulate with oblong-lanceolate sepals and in the latter rounded urn-shaped with broadly ovate sepals. *C. Wyethii* is common in Montana and northern Idaho. It is represented by the specimens cited under *C. Scottii* and some under *C. Douglasii* in my catalogue of the flora of Montana.

ATRAGENE OCCIDENTALIS Homem. Hort. Hafn. 1813: 520

Atragene Columbiana Nutt. Journ. Acad. 7: 7. 1834; *Clematis Columbiana* Torr. & Gray, Fl. N. Am. 1: 10. 1838; *Clematis verticillaris* var. *Columbiana* Gray. Syn. Fl. 1: 8. 1895; *Clematis Pseudoatragene a. normalis* Kuntze, Verh. Bot. Ver. Brandenburg, 26: 160, in part, 1884; *C. alpina a. occidentalis* 3 *typica* Kuntze, l. c. 161.

Dr. Gray adopted the name *occidentalis* as a varietal name for another species, and cites Hometown's plant as a synonym. It is very evident that the latter is the common plant of the Columbia Valley with simply ternate leaves and subentire leaflets, for Hometown expressly describes them as entire. Dr. Kuntze was so far right that he placed *Atragene occidentalis* Hometown with *A. verticillaris*, although he made both forms of *Clematis alpina*. His revision of *Clematis* is far from good especially as to the West American species. The only distinction he makes between *C. pseudoatragene* and *C. alpina* is the absence or presence of stami-

nodia, a very unfortunate distinction, for in most of the West American forms both conditions exist. The filaments of the outer stamens are flattened and more or less petaloid. In some cases the outermost have no anthers (true staminodia), but often all are antheriferous. The present species is therefore placed in both species by Kuntze. *Atragene occidentalis* differs, however, from the eastern *A. Americana* in the fact that the staminodia as far as I know always are linear, while they are in *A. Americana* decidedly spatulate. *A. occidentalis* is common from British Columbia and the Canadian Rockies south to California and Colorado.

Atragene grosseserrata

Trailing or climbing over bushes: leaves ternate; petioles 5–8 cm. long; petiolules 1–2 cm. long; blades broadly ovate, oblique, somewhat cordate at the base, 3–4 cm. long, coarsely toothed and often somewhat lobed: peduncles 5–10 cm. long: sepals lanceolate, about 4 cm. long, 10–13 mm. wide, acute: staminodia about 18 mm. long, decidedly spatulate, a little exceeding the stamens: achenes small, sparingly hirsute: tails about 3 cm. long, plumose throughout.

This is closest related to the eastern *A. Americana*; but the leaves are deeper serrate and the sepals are longer, lanceolate, and resemble more those of *A. tenuiloba*. From *A. occidentalis* it differs in the spatulate staminodia, the shorter leaflets, which are coarsely serrate except the very base. In *A. occidentalis* the leaflets are entire or merely crenate above the middle.

IDAHO: Palouse county and about Lake Coeur d'Alene, 1892, *G. B. Aiton* (type in Herb. N. Y. Bot. Garden, flower).

WASHINGTON: Cascade Mountains, 1882, *F. Tweedy* (fruit).

***Atragene repens* (Kuntze)**

Clematis alpina a *occidentalis* 2 *repens* Kuntze, Verh. Bot. Ver. Brandenburg, 27, 161, in part. 1884.

Plant trailing: leaves biternate, glabrous, firmer than in the two preceding: petioles 5–8 cm. long: secondary leaflets sessile except the terminal, which is short-stalked, broadly ovate, coarsely toothed with broadly ovate teeth, 3–4 cm. long, abruptly short acuminate at the apex: peduncles over 1 dm. long: sepals ovate-lanceolate, about 4 cm. long, acute: staminodia linear: achenes about 5 mm. long, pubescent: tails about 4 cm. long, plumose throughout.

Dr. Kuntze's description of the subvariety *repens* is just as meaningless as the rest of his descriptions. He cites specimens, however, viz., *Jones* no. 1882 and 1887. We have two sheets of each and they evidently do not belong together. No. 1882 in both the Columbia University and New York Botanical Garden herbaria are in fruit, have simply ternate leaves with subentire leaflets and must be referred to *A. occidentalis*. No. 1887 in flowers, on the contrary, has biternate leaves, and the leaflets are coarsely toothed. Dr. Kuntze's subvariety is, therefore, "eine zusammengesetzte" and according to some Germans, should be ruled out. After the part that belongs to *A. occidentalis* has been removed, I have adopted the name for the residue.

UTAH: American Fork, 1880, *M. E. Jones*, 1887 (type in herb. N. Y. Bot. Gard.).

WYOMING: Wolf Creek Cañon, 1896, *Arven Nelson*, 2294, in part, the larger part belonging to *A. tenuiloba*.

***Atragene pseudoalpina* (Kuntze)**

Atragene Ochotensis Gray, Pl. Fendl. 4. 1849. Not Pall. 1874; *A. alpina* var. *Ochotensis* A. Gray, Am. Jour. Sci. II. 33: 241; *Clematis alpina* var. *Ochotensis* S. Wats. Bot. King Exp. 5: 4; *C. alpina* var. *occidentalis* A. Gray; Powell, Geol. Surv. Dakota, 531. 1880. Not *Atragene occidentalis* Homem. 1813; *Clematis pseudoatragene* γ *pseudoalpina* Kuntze, Verh. Bot. Ver. Brandenburg, 26: 160. 1884.

As stated above, the name *occidentalis* should be used for *A. Columbiana* Nutt. We are therefore obliged to adopt Kuntze's varietal name. In the Synoptical Flora *Clematis pseudoatragene* Kuntze is given as a synonym, but from the short description neither of the varieties *α*, *β* or *δ* can belong here. The var. *α normalis* is evidently partly *A. Americana* and partly *A. occidentalis* as here understood. The var. *δ subtritermata* is *A. tenuiloba* (A. Gray) Britton. What *Clematis pseudoatragene* var. *β Wenderothiioides** is I do not know. In the Synoptical Flora the range is given as extending from New Mexico to Dakota and Washington. I have not seen any specimens from any station north of

* What a name! Translated it would mean: A variety of the false *Atragene* Virgin's Bower, resembling Mr. Wenderoth.

Colorado and Utah. All specimens referred here from higher latitudes belong to *A. tenuiloba*.

Ranunculus Utahensis

Perennial with a cluster of fibrous fleshy roots, glabrous : stems 1-2 dm. high, branched above ; basal leaves petioled ; petioles 2-5 cm. long ; blades almost orbicular, rather thick, crenate or round-lobed : stem-leaves sessile, deeply cleft or divided into 4-5 oblong or elliptic, obtuse segments : sepals somewhat hairy, elliptic to obovate, at last reflexed : petals 4-5 mm. long, exceeding the sepals : head of fruit oblong ; achenes glabrous ; style rather short.

This species resembles most a depauperate *R. abortivus* in the leaves, but the petals are much larger and the head of fruit is oblong instead of spherical. It has gone under the name of *R. affinis* var. *leiocarpus*, but it is not that of Trautvetter, and is distinguished from all of those species which have been included in *R. affinis* by its thicker leaves and their lobing.

UTAH : Alta, Wasatch Mts., 1879, *M. E. Jones*, 1130 (type in herb. Columbia University) ; Uinta Mts., 1873, *T. C. Porter*.

Ranunculus micropetalus (Greene)

Ranunculus affinis var. *micropetalus* Greene, Pittonia, 2 : 110. 1890.

An excellent species, very distinct from *R. affinis* Hook., and still more from *R. cardiophyllus* Hook., with which Davis associated it.

Ranunculus Helleri

Perennial with a short rootstock, perfectly glabrous : stem slender, 1-2 dm. high : basal leaves and lower cauline with slender petioles 2-5 cm. long ; blades of the earlier basal leaves reniform, 3-cleft $\frac{2}{3}$ or $\frac{3}{4}$ the distance to the base ; middle division oblong, entire, the lateral ones with 3 ovate lobes ; blades of the other basal leaves and the lower cauline divided to near the base into 3 cuneate divisions, 15-20 mm. long ; the middle division 3-lobed, the lateral ones 4-lobed ; stipules of lower cauline leaves conspicuous, rounded : upper cauline leaves sessile, divided unto the base into 2-4 linear-oblong divisions : flowers solitary : sepals oblong, obtuse, about 5 mm. long : petals oblong to obovate, golden yellow, 6-7 mm. long : head of fruit short-oblong or spherical : achenes turgid, almost spherical, 1.5 mm. long, glabrous : style slender and curved.

This species is nearest related to *R. Eschschotsii* and *R. alpeo-*

philus. In the former, which is very rare in the Rockies, the upper stem-leaves have broad and short lobes, which are elliptical to obovate; and in the latter the basal leaves are not reniform but almost orbicular in outline. *R. Helleri* grows in bogs at high altitudes.

IDAHO: Near Lake Pend d'Oreille, 1892, *Sandberg, MacDougal & Heller*, 842 (type in herb. N. Y. Bot. Gard.).

WYOMING: Big Horn Mountain, 1899, *F. Tweedy*, 2385.

MONTANA: Sperry Glacier, 1901, *F. K. Vreeland*, 1110.

Ranunculus stenolobus

Perennial with a cluster of fibrous roots, perfectly glabrous: stems 1-3 from the same clump, 1-2 dm. high, usually branched: basal leaves and lower cauline petioled; petioles 4-10 cm. long; blades three times ternately dissected into almost linear segments, which are 6-15 mm. long and 1-3 mm. wide, usually somewhat narrowed at the base; the primary divisions distinctly petiolulate: sepals oval, 4-5 mm. long: petals obovate, 7-8 (rarely 9-11) mm. long: head of achene spherical or slightly oblong, about 6 mm. broad: achenes turgid, glabrous: style slender.

This species is somewhat intermediate between *R. adoncus* and *R. triternatus*, but the stem is more elongated and branched. Some of the specimens cited below have been referred to the former, but in that plant the stem is usually simple, the petals over 1 cm. long, cuneate-flabelliform and overlapping each other, the lobes of the leaves narrower and not narrowed downward. In the leaf-form and flowers it resembles more *R. triternatus*, but that grows in big clumps with numerous stems, and the segments are more decidedly petiolulate.

WYOMING: Headwaters of Cliff Creek, 1900, *C. C. Curtis* (type in herb. N. Y. Bot. Gard.).

UTAH: Alta, Wahsatch Mts., 1879, *M. E. Jones*, 1104; Wahsatch Mt., 1869, *S. Watson*, 30.

Papaver pygmaeum

A caespitose and scapose perennial; leaves all basal, numerous 2-3 cm. long; blade less than 1 cm. long, broadly ovate in outline, deeply cleft into rounded-oblong or obovate segments, sparingly hispid or glabrous: scape 4-6 cm. high, sparingly hirsute; so also the calyx, which is obovate in bud: petals yellow, 1 cm. or less long: pod obovoid, about 1 cm. long, densely bristly.

This species is nearly related to *P. radiculatum* Rottb., but is a still smaller plant, with shorter, broader, less divided, less bristly

leaf-blades and smaller flowers. It resembles still more the European *P. Pyrenaicum*, which has larger petals, 1–2 cm. long, stamens much exceeding the ovary and spherical flower-buds.

MONTANA: Mountain above Stanton Lake, 1894, *R. S. Williams*, 992 (type in herb. N. Y. Bot. Garden).

ALBERTA: Sheep Mountain, 1895, *John Macoun*, 10269; top of Rocky Mountains, 1881, *G. M. Dawson*.

Argemone rotundata

Stem stout, densely and strongly bristly, but otherwise glabrous: leaves oval in outline; the cauline ones sessile and broadly auricled, bristly, especially on the veins and margins, round-lobed: flowers short-pedicelled or subsessile: calyx very bristly; its horns erect or slightly spreading, bristly: petals white, fully 4 cm. long: pod ovoid, very bristly.

This has been mistaken for *A. hispida* Gray but is perhaps nearer related to *A. intermedia* and *A. platyceras*. From *A. hispida* it is easily distinguished by the absence of a finer indumentum and by the round-lobed leaves. The latter character also distinguishes it from the other two species mentioned. It is also much more bristly than the two. It grows at an altitude of 1500–1800 m.

NEVADA: Diamond Mountains, July, 1868, *S. Watson*, 47 (type in herb. Columbia University).

UTAH: Utah Valley, 1869, *S. Watson*, 49.

Bicuculla occidentalis

Perennial with a very short rootstock bearing numerous tubers: scape and leaves perfectly glabrous; petioles of about 1.5 dm. long; blades twice ternate; the divisions twice pinnately divided or cleft into linear-oblong lobes, 1–2 cm. long, 3–5 mm. wide: scape about 3 dm. high: raceme simple: sepals oval, about 5 mm. long: petals pink; the outer about 1 cm. long; their spurs about 12 mm., divergent, forming with each other an angle of 90° or more; crest of the inner petals prominent; capsule fusiform, with the style about 1.5 cm. long.

This is nearest related to *B. cucullaria*, and has been confused with it, but has coarser foliage, more diverging and longer spurs, more prominent crest on the inner petals and the underground parts more gruinose and not scaly. Its range includes parts of Oregon, Washington and eastern Idaho, and it grows on shaded hillsides.

WASHINGTON: West Klickitat county, 1892, *W. N. Suksdorf* (type in herb. Columbia University).

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STUDIES ON THE ROCKY MOUNTAIN FLORA
VIII.

BY PER AXEL RYDBERG.

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Studies on the Rocky Mountain Flora—VIII

BY PER AXEL RYDBERG.

Stanleya arcuata sp. nov.

Perennial with a ligneous caudex, 4–10 dm. high, perfectly glabrous; stem light green and shining, in age straw-colored; leaves entire or the lower with short and broad lobes, lanceolate, long-petioled, thick, 5–12 cm. long; pedicels rather short, in fruit, about 1 cm. long; sepals yellow, linear about 15 mm. long; petals yellow; blades 7–8 mm. long, broadly elliptic, almost as long as or at least two thirds as long as the claw; pods 7–10 cm. long, strongly arcuate, and spreading.

This species is nearest related to *S. integrifolia*, but is taller, more shrubby, with narrower leaves and broader petals. *S. pinnata* (Pursh) Britton, with which both have been confused, has hairy leaves, most of which are deeply pinnatifid, and the blades of its petals are linear oblong and only one third or one half as long as the claws. *S. arcuata* grows in dry regions from Wyoming to Nevada and south to Colorado and Arizona; probably also in California.

NEVADA: Unionville Valley, 1868, *S. Watson*, 105 (type in herb. Columbia University).

Stanleya canescens sp. nov.

Stout perennial .5–1 m. high; stem light green, finely puberulent or glabrate, terete; leaves grayish puberulent, the upper entire and oblanceolate, 5–7 cm. long; the lower pinnatifid with oblong lateral lobes and a large oval or elliptic end-lobe; raceme dense, pedicels short, in fruit 1 cm. or less long, divergent; sepals linear, about 12 mm. long; blades of the yellow petals linear-oblong, about half as long as the claw; pods arcuate, spreading, 5–7 cm. long.

This is nearest related to the preceding, differing in the puberulent leaves, which are shorter and broader and more inclined to be pinnatifid.

UTAH: Frisco, 1880, *M. E. Jones*, 1809 (type in herb. N. Y. Bot. Garden).

ARIZONA: Fort Verde, 1887, *E. A. Mearns*; Verde River, 1883, *H. H. Rusby*; *Mexican Boundary Survey*.

Thelypodium macropetalum sp. nov.

A glabrous perennial, 4-6 dm. high: basal leaves oblanceolate or spatulate, short-petioled, 2-5 cm. long: lower stem-leaves oblong, obtuse, sessile, with rounded auricles at the base, 5-6 cm. long; upper leaves lanceolate-sagittate, acute; pedicels in fruit about 1 cm. long, divaricate: sepals about 5 mm, long, purplish with white margins; petals purple, spatulate, long-clawed, nearly three times as long as the sepals: pods 4-5 cm. long, ascending or erect and somewhat incurved.

This is related to *T. sagittatum* (Nutt.) Heller and *T. paniculatum* A. Nelson. From the former, it differs in the smaller leaves, the rounder auricles, the erect, not reflexed nor spreading pod; and from the latter by the much longer petals. It grows at an altitude of 1,000-1,200 m.

UTAH: Farmington, 1881, *M. E. Jones*, 1841 (type in herb. N. Y. Bot. Garden).

IDAHO: Soda Springs, 1892, *Isabel Mulford*.

Thelypodium Utahense sp. nov.

Annual or biennial: stem 4-6 dm. high, sparingly pubescent below; leaves all lanceolate in outline, 5-10 cm. long, lanceolate, glabrous; segments broad and crowded, oblong-lanceolate to triangular: pedicels very short, in fruit scarcely more than 1 mm. long: sepals oblong, about 2 mm. long: petals spatulate, almost twice as long, white: pod about 3 cm. long, strongly reflexed.

This is probably nearest related to *S. reflexum* Nutt., which is decidedly hispid on the stem and the veins of the leaves and has much narrower leaf-segments. It grows at an altitude of about 600 m.

UTAH: St. George, 1880, *M. E. Jones* (type in herb. N. Y. Bot. Garden); 1877, *E. Palmer*, 28.

Lepidium Jonesii sp. nov.

Lepidium montanum var. *alyssoides* Jones, *Zoe*, 4: 266. 1893.
Not *L. alyssoides* A. Gray. 1849.

Perennial with a short woody caudex: stems 2-3 dm. high, glabrous, branched, glabrous: basal leaves pinnatifid with linear acute divisions; stem-leaves similar or the upper entire, narrowly linear: racemes rather short and dense; pedicels in fruit 6-8 mm. long, spreading: sepals oblanceolate, obtuse; petals white, much

exceeding the sepals ; blade broadly obovate : pod acutish, oval in outline, about 4 mm. long and slightly over 2 mm. wide, glabrous, reticulate, only slightly wing-margined above, retuse ; style about twice as long as the width of the wing margins.

This species is in some respects intermediate between *L. alyssoides* and *L. montanum*. In the former only the lowest leaves are pinnatifid, the pod is more rounded and the style is shorter, scarcely longer than the width of the wing-margin. It is closer related to *L. montanum*, differing mainly in the longer and narrower leaf-segments, having a more persistent base and being less pubescent.

UTAH : St. George, 1880, *M. E. Jones*, 1636 (type in herb. N. Y. Bot. Garden) ; Price, 1900, *S. G. Stokes* ; southern Utah, 1874, *C. C. Parry*, 18.

NEVADA : Trinity Mountains, 1868, *S. Watson*, 120.

***Lepidium elongatum* sp. nov.**

Annual : stem branched near the base, about 3 dm. high, glandular pruinose above : basal leaves spatulate or oblanceolate, about 4 cm. long, coarsely toothed or somewhat pinnatifid with short lobes ; stem leaves oblanceolate, tapering into a short petiole, entire or with a few small teeth, 3-4 cm. long, acutish : racemes elongated, at the ends of the branches, in fruit 1 dm. or more long : sepals oblong or oblanceolate, acute, thin and whitish ; petals minute, linear-oblanceolate, one half to two thirds as long as the sepals or lacking : pods nearly orbicular, about 3 mm. broad, usually broadest a little above the middle, wing-margined and deeply retuse at the apex, glabrous or slightly pruinose : stigma sessile.

This species is nearest related to *L. apetalum* and *L. ramosissimum*. From the former it differs in the branching near the base, the more entire leaves, the somewhat larger pod and the petals which are generally present ; and from the latter in the longer racemes, in the lack of the small axillary racemes characteristic to that species and a different pod. In *L. ramosissimum* this is broadest below the middle. *L. elongatum* grows on rocky hilltops.

WASHINGTON : Almata, 1896, *A. D. E. Elmer*, 21 (type in herb. N. Y. Bot. Gard.).

IDAHO : About Lewiston, 1896, *A. A. & E. Gertrude Heller*, 3008.

Thlaspi Nuttallii

Thlaspi cochleariforme Nutt. Journ. Acad. Phila. 7: 13. 1834.
Not DC. 1821.

This species has been merged in *T. alpestre*, but none of our American forms belong to that species. *T. Nuttallii* is intermediate between *T. parviflorum* A. Nelson and *T. glaucum* A. Nelson, having larger flowers than the former and smaller than the latter. The pod is obovate, rounded at the apex with a narrow sinus. In *T. glaucum* the sinus is broad and open.

Roripa clavata sp. nov.

Biennial, tall, perfectly glabrous: stem 6–10 dm. high, simple up to the inflorescence: leaves lyrate-pinnatifid, 5–10 cm. long, more or less auricled at the base; lobes 4–8 pairs, oblong to ovate, obtuse or acute, broadly dentate: inflorescence branched; petioles in fruit 5–10 mm. long, divaricate: petals spatulate, about 3 mm. long, exceeding the sepals: pod 10–12 mm. long, 2.5–3 mm. thick, decidedly clavate, obtuse, strongly curved; style nearly 1 mm. long.

This may have been included in Watson's *Nasturtium terrestre* var. *occidentale*: but the name *occidentale* cannot be used as there is already another older *Roripa occidentalis* Greene. It is not, however, *Roripa Pacifica* Howell, which is supposed to be a synonym of Watson's variety, for that species is described as being slightly pubescent and having pods which are acute at both ends, while in *R. clavata* the pod is almost truncate at the apex.

WASHINGTON: Hogeman, Chehalis county, 1897, *Frank H. Lamb*, 1221 (type in herb. N. Y. Bot. Gard.); West Klickitat county, 1885, *W. M. Suksdorf*.

OREGON: Sauvie's Island, 1888, *T. Howell*, 1333.

BRITISH COLUMBIA: Port Henry, 1889, *John Macoun*.

IDAHO: Near Hope, Kootenai county, 1892, *Sandberg*, *MacDougal & Heller*, 1029, at least in part.

Roripa Underwoodii sp. nov.

Biennial, divaricately branched, even near the ground, perfectly glabrous; stems 2 dm. or more high: leaves 3–5 cm. long, lyrate-pinnatifid, thin; lobes oblong, obtuse; the terminal one elliptic to broadly oval, sinuately toothed; petioles short, winged and

conspicuously auricled at the base: racemes numerous: pedicels short, in fruit scarcely more than 4 mm. long, diverging or even reflexed: sepals bright orange, obtuse; petals light yellow, scarcely equalling the sepals and not quite 1 mm. long: fruit (immature) 5-6 mm. long, slightly thicker at the base, abruptly contracted into a minute style, not .5 mm. long.

In general appearance, this species resembles most *R. palustris*, but it is more branched with divaricate branches, has much shorter pedicels, rather longer and more tapering pod and not half as long style. From *R. obtusa*, it differs in the shape of the leaves, which are less dissected, the shorter style and general habit. The type grew at an altitude of 3300 m.

COLORADO: Red Mountain, south of Ouray, 1901, *L. M. Underwood*, 299a.

***Roripa integra* sp. nov.**

Biennial, glabrous: stems few, strict, branched above; basal leaves not seen as they are fallen off in the type specimen; stem-leaves spatulate or rhombic spatulate, 1-2 cm. long, not auricled at the base, entire or slightly sinuate: racemes slender, lax: petals 1.5 mm. long, scarcely exceeding the sepals; pedicels 1-3 mm. long, ascending: pod about 8 mm. long, somewhat curved: style about 5 mm. long.

The type specimen is labelled *Nasturtium palustre* var., but it is not closely related to this species. It is nearer *R. obtusa*, but differs in the entire leaves; the more tapering and more curved pod, the erect habit and the short style. It grows at an altitude of about 2700 m.

UTAH: Wasatch Mountains, 1869, *S. Watson*, 64, in part (type in herb. Columbia University).

***Lesquerella arenosa* (Richards).**

Vesicaria arenosa Richardson, Frankl. Journ. App. 743.

Lesquerella Ludoviciana var. *arenosa* S. Wats. Proc. Am. Acad. 23: 252.

This is amply distinct from *L. Ludoviciana* (DC.) S. Wats. or *L. argentea* (Pursh) MacM., by the more slender ascending stems, the shorter leaves, the oblanceolate, instead of linear stem-leaves and the comparatively larger and often somewhat ellipsoid pod. The range given in the Synoptical Flora should be extended to the Black Hills of South Dakota and northeastern Wyoming.

Lesquerella Shearis sp. nov.

Perennial with a large rosette of basal leaves; stems several, ascending, 1–2 dm. high, densely stellate: basal leaves 3–4 cm. long; blades broadly oval or ovate, entire or slightly angular denticulate; stem leaves oblanceolate, about 2 cm. long, subsessile: raceme many-flowered; pedicels in fruit bent S-shaped: pods erect, densely stellate, 7–8 mm. long, acute, compressed above; septum elliptic in outline: style about as long as the pod.

This species differs from *L. curvipes* A. Nelson in the broad basal leaves, the elliptic instead of ovate outline of the septum and the longer style. It grows along creek banks at an altitude of about 2000 m.

COLORADO: Idaho Springs, 1895, *C. L. Shear*, 3269 (type in herb. N. Y. Bot. Gard.); also at the same locality, *P. A. Rydberg*.

Physaria brassicoides sp. nov.

A tufted perennial with a large and dense rosette of basal leaves and a thick taproot: basal leaves large, with winged petioles; blades almost orbicular in outline, sinuate-dentate, 2.5–5 cm. in diameter: stem leaves small and few, spatulate: flowering stems about 1 dm. high, ascending: flowers numerous: fruit almost obcordate, acute at the base, deeply divided above; cells inflated, rounded pyriform, 8–10 mm. long and 5–8 mm. in diameter: style about 5 mm. long.

This species resembles most *P. didymocarpa* in habit, but differs in the smaller fruit, which is not at all cordate at the base but on the contrary usually acute, and in the larger basal leaves which form a large rosette, 7–10 cm. in diameter and having some resemblance to a young cabbage-head. It grows in crevices of magnesian rocks in cañons and badlands.

NEBRASKA: Cañon south of Scott's Bluffs, 1891, *Rydberg*, 24.

Cardamine acuminata (Nutt.)

Cardamine hirsuta β *acuminata* Nutt.; T. & G. Fl. N. Am. 1: 85. 1838.

This species has been variously referred to *C. hirsuta*, *C. oblongosperma*, and *C. Pennsylvanica*. It is probably nearest related to the last, but the lower part of the stem is hairy and the pod has an evident style over 1 mm. long. It ranges from the Mackenzie River to British Columbia, south to California and Wyoming.

Cardamine multifolia sp. nov.

Stem about 2 dm. high, very leafy, lower part hirsute: leaves 4-6 cm. long glabrous; leaflets 7-13, oblong to oblong-obovate or oval, entire or sinuate-dentate; the terminal one larger and obovate: flowers numerous: petals spatulate, about 2.5 mm. long; pedicels ascending, about 8 mm. long: pod erect, about 2 cm. long and .75 mm. wide.

This is perhaps closest related to *A. parvifolia* L., but is more leafy, has shorter and broader leaf-segments and erect pods, and the plant is less diffusely branched.

IDAHO: Beaver Cañon, 1895, *P. A. Rydberg*.

UTAH: Wasatch Mts., 1869, *S. Watson*, 80, in part.

Sophia brevipes (Nutt.)

Sisymbrium canescens $\tilde{=}$ (*brevipes* Nutt. MSS.) Torr. & Gray, Fl. N. Am. **1**: 92. 1838.

Sisymbrium Hartwegianum Fourn. Rech. Auct. & Tax. Fam. Cruc. & Gen. Sisymb. 66, in part. 1865.

Sisymbrium incisum var. *Hartwegianum* S. Wats. Bot. Calif. **1**: 41.

The plant described by Dr. Watson in the Botany of California and by Dr. Robinson in the Synoptical Flora (p. 139) is I think without doubt the var. *brevipes* of Torrey and Gray's flora. Probably also Bourgeau's plant, cited by Fournier, belongs here; but I think that it is very doubtful that Hartweg's plant, which must be regarded as the type of *S. Hartwegianum* Fourn., could be the same.

Sophia Californica (T. & G.)

Sisymbrium canescens ε (*Californicum*) T. & G. Fl. N. Am. **1**: 92. 1838.

This species is characterized by the large flowers, the sparingly stellate and often glandular-puberulent stem, the uniserial linear pod and once or twice pinnatifid leaves. The segments of the lower leaves are broad and obtuse, those of the upper linear to oblong. Its range extends from Montana to Washington south to California.

Sophia viscosa sp. nov.

Biennial, 5-10 dm. high: stem, at least the upper part, decidedly glandular or viscid-villous: leaves obovate or oblanceolate in out-

line, 3-10 cm. long, twice pinnatifid, densely pubescent; primary divisions of the lower leaves ovate and obtuse; those of the upper lanceolate and acute; secondary divisions oblong acute or obtuse, often few-toothed: inflorescence usually much branched; pedicels in fruit 8-12 mm. long: sepals yellowish, 1-15 mm. long, oblong; petals bright yellow, spatulate, about 2 mm. long: pod (in the specimens seen not fully developed) over 1 cm. long and less than 1 mm. wide: seeds uniserial.

This is perhaps nearest related to *S. incisa* (Engelm.) Greene; but differs in the dense viscid pubescence of the stem, the pubescent leaves and deeper divided primary segments. It grows among rocks and on grassy slopes.

IDAHO: Beaver Cañon, 1895, *C. L. Shear*, 3029 (type in Herb. N. Y. Bot. Garden) and 3031.

WYOMING: Trout Lake, 1899, *Aven & Elias Nelson*, 5848; Head of Pole Creek, 1895, *Aven Nelson*, 1321.

***Sophia leptophylla* sp. nov.**

Stems 5-7 dm. high, sparingly glandular: leaves very thin, dark green, only once pinnate; segments of the lowest leaves rounded; those of the middle lanceolate and somewhat incised; the upper segments entire: pedicels slender, in fruit 5-8 mm. long, spreading: petals bright yellow, about 1.5 mm. long: pod linear, 8-10 mm. long, much less than 1 mm. wide, torulose, spreading, arcuate, curved up, uniserial.

This is nearest related to *S. incisa* (Engelm.) Greene, but differs in the less incised leaves and horizontal curved pod. It grows at an altitude of about 2000 m.

COLORADO: Foothills, Larimer county, 1895, *Crandall & Coven*, 55 (type in herb. N. Y. Bot. Gard.).

WYOMING: Antelope Basin, Albany county, 1900, *Aven Nelson*, 7466; Centennial Hills, 1895, 1686.

Smelowskia Americana

Hutchinsia calycina Hook. Fl. Bor. Am. 1: 58. 1834. Not Desv. 1814.

Smelowskia calycina Gray, Proc. Acad. Philad. 1863: 58. Not C. A. Mey. 1831.

While in Europe last summer, I looked up the Asiatic type of *S. calycina*, and this differs considerably from ours especially in the long villous pubescence.

***Draba brachystylis* sp. nov.**

Perennial with a taproot: stems several, decumbent or ascending with divergent branches, 1-1.5 dm. high, hirsute: basal leaves oblanceolate or spatulate, 1.5-2 cm. long, hirsute with branched hairs; stem leaves few, oblong or lanceolate, sessile: pedicels short, in fruit 2-5 mm. long, spreading: pod oblong, finely stellate, 8-12 mm. long, ascending: style very short, almost obsolete.

The type sheet of this species is labeled *Draba Carolina* var. *micrantha*, but the plant evidently is a perennial and nearest related to *D. streptocarpa*; but differs in the divergently branched stem, stellate pod and the almost obsolete style. It grows at an altitude of about 3000 m.

UTAH: Alta, Wasatch Mts., 1879, *M. E. Jones*, 1357 (type in herb. N. Y. Bot. Gard.).

***Draba decumbens* sp. nov.**

Perennial with a taproot, a short caespitose caudex and a large rosette of basal leaves: stems decumbent, 1-2 dm. high, sparingly pubescent, few-leaved; basal leaves broadly spatulate, entire, 2-4 cm. long, finely grayish stellate, rather thick; stem leaves ovate to ovate-lanceolate, sessile, entire, 1-2 cm. long: calyx sparingly villous; petals pale yellow, about 4 mm. long: pedicels very short, in fruit 2-4 mm. long: pod oblong, 8-15 mm. long, densely pubescent, usually twisted: style about 1 mm. long.

This is a member of the *D. aurea* group, and distinguished from all the North American species by its decumbent stems, large, thickish entire basal leaves.

COLORADO: Gray's Peak, 1895, *Rydberg* (type in herb. N. Y. Bot. Gard.).

***Draba Macouniana* sp. nov.**

Annual, almost scapose: stems ascending or decumbent, less than 1 dm. high, glabrous and shining; basal leaves numerous, broadly spatulate or obovate, 5-10 mm. long, finely stellate, rather thick; stem leaf usually one, oval, obtuse, 5 mm. long: petioles in fruit spreading, 6-8 mm. long: petals white, less than 3 mm. long: pod oblong-linear, erect, about 1 cm. long and 2 mm. wide: style obsolete.

This species is nearest related to *D. crassifolia*, but differs in the whiter flowers, and the broad and short basal leaves, which are finely stellate, not hirsute ciliate. The type grew at an altitude of about 2000 m.

BRITISH COLUMBIA : Summit of Rocky Mountains, 1890, *John Macoun* (type in herb. Columbia University).

***Draba Parryi* sp. nov.**

Annual, perfectly glabrous, except a few cilia on the petioles : stems several, usually less than 1 dm. high, scapiform or rarely with a stem leaf : basal leaves numerous, linear or narrowly linear-oblong, 1.5–2.5 cm. long ; pedicels spreading, in fruit 5–8 mm. long : flowers small ; petals scarcely 2 mm. long, white or light yellow : pods erect, oblong, 5–8 mm. long, 1.5–2 mm. wide, glabrous : style obsolete.

This is closely related to *D. crassifolia* but the latter has broader leaves, which are more or less hirsute on the surface and distinctly ciliate on the margins.

COLORADO : Foot of Gray Peak, 1872, *E. L. Greene* (type in herb. Columbia University) ; 1872, *C. C. Parry* ; Cameron Pass, 1896, *C. F. Baker*.

WYOMING : Telephone Mines, 1900, *Aven Nelson*, 7879.

***Draba cana* sp. nov.**

Perennial with a taproot and short cespitose caudex, whole plant densely grayish stellate ; stem 1–2 dm. high, often branched : basal leaves numerous, oblanceolate or spatulate, 1–1.5 cm. long, entire or minutely but sharply toothed, densely stellate ; stem leaves lanceolate to ovate, about 1 cm. long : racemes many-flowered ; pedicels short, nearly erect, in fruit 2–3 mm. long : flowers small ; petals white, about 3 mm. long : pod linear-oblong, 6–8 mm. long, densely pubescent : style about 5 mm. long.

This has gone under the name of *D. incana*, but the latter is much less densely stellate and has a glabrous, much broader pod. I have seen only one specimen of true *D. incana* from this continent, and it was collected in Labrador. Most of those under this name belong to *D. cana*, which ranges from Labrador to the Yukon Territory, south in the mountains to Colorado. The following is regarded as the type.

ALBERTA : Morley, foothills of the Rocky Mountains, 1887, *John Macoun* (herb. Columbia University).

***Draba McCallae* sp. nov.**

Perennial with a cespitose base, whole plant sparingly stellate but green : stems several, simple, about 3 dm. high : basal leaves

spatulate, 10–18 mm. long, entire or nearly so ; stem leaves ovate, about 1 cm. long, sharply dentate or entire : raceme elongated : pedicels slender, in fruit about 1 cm. long, erect : petals white, 4–5 mm. long : pod (in the specimen not fully developed) ovate, densely but finely pubescent, much shorter than the pedicels : style 0.75 mm. long.

This species belongs also to the *D. incana* group, but differs from that species in the elongated peduncle, long pedicels, short pubescent pod and large petals.

Alberta : Valley below Mt. Aylmer, 1899, *W. C. McCalla*, 2267 (type in herb. N. Y. Bot. Gard.).

***Draba Columbiana* sp. nov.**

Perennial ; with a caespitose base, sparingly and finely stellate and ciliate on the margin of the leaves : stems slender, about 2 dm. high, simple : basal leaves many, oblanceolate, 10–15 mm. long, denticulate or entire ; stem leaves ovate to lanceolate, about 1 cm. long denticulate : raceme elongated, pedicels slender, ascending, 5–7 mm. long in fruit : flowers small ; petals slightly over 2 mm. long, white : pods linear-oblong, finely pubescent, over 1 cm. long, style very short.

This species resembles much the preceding in habit, but the flowers are much smaller and the pods longer.

BRITISH COLUMBIA : Revelstoke, 1890, *John Macoun* (type in Herb. Columbia University).

***Geranium Pattersonii* sp. nov.**

Cespitose perennial with a thick root and short caudex : stems ascending or diffuse, 2–4 dm. long, densely glandular villous with long spreading hairs, petioles of the basal leaves 5–10 cm. long, also glandular villous ; blades reniform in outline, about 3 cm. broad, glandular villous on both sides, deeply 5–7-cleft ; lobes broadly obovate-cuneate, 3-toothed ; teeth broadly ovate, abruptly short-acuminate : stem leaves similar, but short-petioled or the uppermost subsessile : pedicels and calyx glandular long-villous ; the former in fruit 1.5–2 cm. long : sepals in fruit about 8 mm. long, oval with a short bristle-tip about 1 mm. long : petals obovate about 1 cm. long, light purple, or rose color, with darker veins : style in fruit about 2 cm. long, glandular-pubescent ; beak about 4 mm. long : carpels pubescent : seeds finely reticulate.

This species is perhaps nearest related to *G. Parryi* (Engelm.) Heller, but is lower, more densely glandular, has broader and

shorter lobes to the leaves and their teeth are broadly ovate, abruptly acuminate, instead of lanceolate. The general habit is perhaps more like *G. cacasipitosum* James, but in that species the lower part of the stem is grayish-pubescent with short reflexed hairs. *G. Pattersonii* is a subalpine plant growing at an altitude of 2500–3000 m.

COLORADO: Gray Peak, 1895, *P. A. Rydberg* (type in herb. N. Y. Bot. Gard.); foot of Pikes Peak, 1896, *C. L. Shear*, 3702; mountains, near Empire, 1892, *H. N. Patterson*, 177 and 176 in part; North Cheyenne Cañon, 1896, *Ernest A. Bessey*; also 1845. *Fremont*, 61.

***Geranium strigosum* sp. nov.**

Geranium Richardsonii Wats. King's Rep. 5: 49, in part. 1871. Not Fisch & May.

Erect perennial with a short thick rootstock: stem 4–8 dm. high, finely reflexed strigose; petioles of the basal leaves 2–5 dm. long, also sparingly strigose; blades reniform in outline, 7–12 cm. in diameter, finely strigose on both sides, deeply 7-cleft; divisions rhombic in outline, 3-cleft and toothed; teeth lanceolate, acute; stem leaves similar, but short-petioled; stipules linear-lanceolate, long-attenuate; inflorescence open, glandular pubescent; sepals densely glandular, oval, about 8 mm. long; bristle tips 1.5–2 mm. long; petals broadly obovate, rose color or light violet, strongly purple-veined; style in fruit about 3 cm. long, beak about 6 mm.: seeds reticulate.

This is nearest related to *G. viscosissimum*, but the corolla is lighter in color and the pubescence is different, being decidedly reflexed, strigose, not at all glandular, except on the inflorescence. It grows in the valleys to an altitude of perhaps 2700 m.

WYOMING: Copperton, 1901, *F. Tweedy*, 4591 (type in herb. N. Y. Bot. Gard.); Big Horn Mountains, 1900, 3647.

UTAH: City Creek Cañon, 1880, *M. E. Jones*, 1871; Parley's Cañon, 1901, *S. G. Stokes*; Black Rock and Uintahs, 1869, *S. Watson*, 204.

***Oxalis Coloradensis* sp. nov.**

Perennial with a slender rootstock: stem slender, erect, 1–2 dm. high, sparingly villous; leaves digitately ternate; petioles 2–4 cm. long, sparingly villous; leaflets broadly obcordate, gla-

brous, 8–12 mm. long : peduncles very slender, about 5 cm. long : inflorescence cymose, but often reduced to 2–3 flowers ; pedicels sparingly strigose : sepals 4–5 mm. long, oblong : petals yellow, 6–7 mm. long : pod cylindric with a conical apex, 12–15 mm. long, 2.5–3 mm. wide, glabrous.

This is nearest related to *O. cymosa* Small and *O. Brittoniac*, but differs from the former in the blunter sepals, the appressed pubescence of the pedicels and the glabrous pod, and from the latter in the simpler habit, the longer glabrous pod and paler and larger leaves. It grows in grassy valleys at an altitude of 1800–2500 m.

COLORADO : Sangre de Christo Creek, 1900, *Rydberg & Ireland* 5920 (type in herb. N. Y. Bot. Gard.); Foothills, Larimer county, 1895, *J. H. Cowen* (mixed with *O. stricta* L.).

Lupinus Scheuberae sp. nov.

Perennial ; stem 4–6 dm. high, sparingly strigose or almost glabrous, slender : petioles of basal leaves about 1 dm. long ; leaflets 7–8, oblanceolate, 5–7 cm. long, acute and mucronate, green, glabrous above, sparingly appressed pubescent beneath ; stipules lanceolate, attenuate ; stem leaves similar but shorter petioled : racemes 1–1.5 dm. long, not dense ; bracts lanceolate, 7–8 mm. long, deciduous : flowers 10–12 mm. long : calyx densely white silvery puberulent, strongly gibbous above ; lower lip lanceolate, fully twice as long as the triangular-ovate upper lip : corolla dark purple but lighter and almost white towards the base ; banner slightly longer than the wings, silky puberulent on the middle of the back : pod densely white silky with appressed hairs, 2–4-seeded.

This is nearest related to *L. pseudoparviflorus*, but differs in the somewhat larger flowers, the strictly appressed white pubescence on the calyx and pedicels, the gibbous, but not spurred calyx, and the broad and short upper lip of the latter. It grows in woods at an altitude of 2,000–2,400 mm.

MONTANA : Garnet county, 1901, *Mrs. Emma Ware Sheuber*, 135 (type in herb. N. Y. Bot. Gard.).

WYOMING : Copperton, 1901, *Frank Tweedy*, 4216.

Lupinus spathulatus sp. nov.

Lupinus parviflorus S. Wats. King's Rep. 5: 1871. Not Nutt.

Perennial : stem 8–10 dm. high, glabrous or sparingly strigose above, leafy ; stipules narrowly lanceolate, attenuate : petioles 3–5 cm. long ; leaflets about 7, spatulate or broadly oblanceolate, about 4 cm. long, mucronate, those of the lower leaves obtuse, those of the upper more acute, glabrous above, finely puberulent beneath ; raceme elongated, about 2 dm. long, many-flowered : flowers subverticillate ; pedicels about .5 cm. long, as well as the calyx, pubescent with short spreading hairs ; bracts lanceolate, attenuate, deciduous, longer than the buds ; calyx gibbous at the base ; lower lip lanceolate, about twice as long as the short ovate upper one : corolla dark blue, with lighter keel ; banner glabrous, rounded and shorter than the wings.

This has been confused with *L. parviflorus*, which it closely resembles, differing mostly in the shape of the calyx ; the lower lip in that species is only slightly longer than the upper and the banner is larger and less rounded. The type grew at an altitude of 2400 m.

UTAH : Wasatch Mountains, 1869, *S. Watson*, 225 (type in herb. Columbia University).

***Lupinus flavescens* sp. nov.**

Perennial : stem about 3 dm. high, appressed pubescent with rather long hairs : stipules lanceolate, densely hairy : petioles often over 1 dm. long, appressed silky ; leaflets about 7, oblanceolate, 3–4 cm. long, appressed silky on both sides : inflorescence short ; bracts lanceolate, early deciduous ; pedicels 8–10 mm. long, as well as the calyx densely pubescent with short, spreading hairs : calyx gibbous at the base ; its lips almost equal in length, both about 8 mm. long ; corolla 12–14 mm. long, pale yellow ; banner with a darker spot, glabrous.

The type has been known as *L. sulphureus* and was included therein questionably by Watson ; but differs in the larger, paler flowers, and the longer lips of the calyx, and the longer pubescence.

IDAHO or MONTANA : Medicine Clay Prairies, *Wyeth* (type in herb. Columbia University).

***Lupinus lucidulus* sp. nov.**

Perennial : stem 5–6 dm. high, branched above, finely silky strigose, especially the upper portions, leafy ; stipules minute, ovate, acuminate : petioles 3–5 cm. long ; leaflets 7–8, linear-oblanceo-

late, silky and silvery on both sides, about 3 cm. long : raceme 1-2 dm. long, lax : flowers scattered ; pedicels and calyx densely pubescent with short strictly appressed silky hairs ; lower lip of the calyx about 5 mm. long, lanceolate, almost twice as long as the short ovate upper one : corolla yellow or light pink ; banner slightly exceeding the wings, with a few short hairs on the back, with a darker spot, about 8 mm. long : pods densely silky pubescent.

This species is nearest related to *L. sulphureus*, but differs in the more silvery pubescence, the smaller flowers and the appressed pubescence of the calyx and pedicels. The type grew at an altitude of 1900 m.

WYOMING : Spread Creek, 1897, *F. Tweedy*, 271 (type in herb. N. Y. Bot. Garden).

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THE NIDULARIACEAE OF NORTH AMERICA

BY V. S. WHITE.

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The Nidulariaceae of North America*

BY V. S. WHITE

(WITH PLATES 14-18)

The members of the family Nidulariaceae are small fungi, seldom attaining a height of 15 mm., the average height being from 5-7 mm. The ripe sporophores are usually more or less regularly cup-shaped, containing from 10-20, or in some species, more, lenticular seed-like bodies, which are analogous to the chambers of the gleba in the other chief groups of the gastromycetes; these bodies are usually known as sporangioles or peridiola, while the cup is known as the peridium.

They are widely distributed, as will be shown in the following pages, and several of the species are fairly common, appearing principally in wet weather, in late summer and autumn, often per-

* This revision of the family was made possible by the large amount of material found at the New York Botanical Garden, principally forming part of the Ellis collection, and by additional material furnished by Professor L. M. Underwood, from his own private collection. Professor F. S. Earle and Professor C. H. Peck also kindly loaned specimens. Thanks are due to Professor G. F. Atkinson, of Cornell University, for the loan of three drawings of *Nidularia Alabamensis* made by Mr. H. Hasselbring, and for a specimen of this same species; to Professor Farlow, of Harvard University, for kindly allowing specimens of *Cyathus pallidus* Berk. & Curt. and *Cyathus Wrightii* Berk., to be examined and sketched; to Mr. Stewardson Brown, of the Philadelphia Academy of Science, for his courtesy in facilitating the examination of Schweinitz's specimens nos. 2211-2220; to Miss Anna Murray Vail, Librarian of the New York Botanical Garden, for help in tracing references; to Mr. E. S. Salmon, for looking up some data at Kew, England, and most especially to Professor L. M. Underwood, under whose direction the work was undertaken.

sisting through the winter months. They grow on manure, sticks, shavings, dried herbaceous plants, and *Crucibulum crucibuliforme* is frequently found on old pieces of sacking. On a certain old board walk at Lakewood, N. J., this last species was found by the hundred growing in regular series between the joints of the boards. A further study of the plants will probably show that they are far more common and widely distributed than is at present thought, for they are likely to escape detection owing to their small size and inconspicuous coloring.

The order Nidulariales comprises but one family, the Nidulariaceae. Until quite recently this family was considered by De Toni* and others to include the genera *Cyathus*, *Crucibulum*, *Nidularia*, *Thelobolus*, *Dacryobolus*, *Sphaerobolus*, *Polyangium* and *Atractobolus*, the last two included as doubtful genera. Fries† included besides the three first mentioned genera, *Arachnion* Schwein. *Myriococcum* Fries, and *Polyangium* Link. The two latter genera are certainly out of place here, *Myriococcum* belonging under the Perisporiales,‡ and *Polyangium* is not mentioned by either Saccardo or Fischer. In Fischer's revision of the family in 1899, he places *Arachnion* Schwein.§ under "Doubtful Genera" in the Sclerodermataceae; for *Sphaerobolus* Tode he establishes a separate family; *Thelobolus* is placed under the Ascobolaceae, and *Dacryobolus* and *Atractobolus* are included in the same family but as doubtful genera.

This leaves only the three genera, *Cyathus* (for which there is an earlier form of the name, *Cyathia*) *Crucibulum*, and *Nidularia*, in this family. Concerning the last genus a question already raised by Otto Kuntze presents itself in regard to the correct name, since Roth's *Granularia*|| antedates Fries and Nordholm's *Nidularia*¶ by over a quarter of a century. Roth's description and figure of *Granularia pisiformis* place this genus on a certain footing, and there can be no hesitation in answering the above question. Recently some

* Saccardo, Syll. Fung. 7 : 28. 1887.

† Syst. Myc. 2 : 296. 1822.

‡ Saccardo, Syll. Fung. 1 : 29. 1882.

§ Engler & Prantl, Nat. Pflanzenzenfam. 11:*** : 339. 1899.

|| Ust. Ann. Bot. 1 : 6. pl. 1. f. 1. 1791.

¶ Syn. Gast. 2. 1817-18.

plants resembling *Crucibulum* in habit * have been described under *Nidularia* which differ so much in the peridial structure and character from the type of the genus, with the exception of not having the sporangioles attached to the inner wall of the peridium, that it seems best to establish another genus in order to simplify as much as possible the arrangement of the family. It was ardently desired to retain the name *Nidularia*, but unfortunately it has been found impossible to do this as all seven of the species which Fries † gives under his section *Nidularia* conform to the type of *Granularia*, so the name *Nidularia* must pass into synonymy.

It is interesting to note that Corda ‡ included only *Nidularia* and *Cyathus* under the Nidulariaceae. Nees noted a resemblance between this family and *Polysaccum*, but the latter genus is included by Fischer § under the Sclerodermataceae as *Pisolithus* Alb. & Schwein.

Although the members of this family have been mentioned in nearly all works treating of fungi from the time of Clusius, 1601, little was known of their structure and life habits until 1842, when Schmitz || wrote a short paper on *Cyathus*, and two years later the brothers Tulasne, ¶ instigated by this first effort to continue the study of these interesting plants, prepared their treatise on the organization and fructification of the Nidulariaceae, which, with the supplementary work of Sachs, ** Eidam †† and Brefeld, ‡‡ forms the foundation of our exact knowledge of this group of fungi.

The American species have never been monographed, and even the mention of plants belonging to this family has been comparatively infrequent.

* Under *Crucibulum* De Bary (Comp. Morph. 321) calls attention to the fact that he was unable to find a funiculus in some peridioles but says "the coil always showed a small point which answers to it." In the specimens referred to this genus there was absolutely no trace or rudiment and it would be impossible even in young sporangioles to determine to which side they had been attached.

† Anleit. 103. 1842.

‡ Syst. Myc. 2 : 300. 1823.

§ L. c. 338.

|| Ueber *Cyathus*. Linnaea, 16 : 141. pl. 6, 7. 1842.

¶ Ann. Sci. Nat. III. 1 : 41-107. pl. 1844.

** Bot. Zeitung, 833-845, 849-861. 1855.

†† Cohn's Beitr. z. Biol. 2 : 221-245. 1876.

‡‡ Bot. Mitt. über Schimmelpilze, 3 : 176-180. 1877.

For a long time the Nidulariaceae seemed to be a bone of contention among various botanical writers, in the fact of their apparently differing from other fungi in having true and visible seeds.* In 1688 Camerarius published a dissertation "de Fungo calyciformi seminifero," setting forth his ideas on the subject and claiming that these fungi had seeds. Marsigli in 1713, on the contrary, tried to exclude what he calls "these simple plants" from the fungi, no fungi having true seeds as these plants seemed to have. In 1714 Tournefort was also inclined to exclude them from the fungi, but Ant. de Jussieu in 1728, denied these propositions, and claimed emphatically that fungi have seeds like true plants. Forty years later fungi were still being classed outside of the vegetable kingdom, particularly so because the sporangioles of *Cyathus* were never seen to germinate. Necker in 1783 wanted to make an intermediate kingdom to consist of the fungi, and Pico five years later, said that he had absolutely proved that the nature of these productions was purely animal. In 1791, Bulliard incontestibly proved that all fungi have seed, but he called the sporangioles of *Cyathus* seeds, and added "that they seem somewhat out of proportion to the size of the fungus." Hoffman says "potius capsula seminalis quam semen ipsum"—"they are less seeds than capsules filled with seeds," while Micheli said that the spores are hard to see with a good magnifying glass.

These fungi have had several popular names, probably owing to their quaint and attractive appearance. Besides the well-known name of "bird's-nest fungi," as far back as 1724 they have been "called in Worcestershire corbells, where they grow plentifully,"† and in Lincolnshire "we find that a kind of fungus like a cup or old-fashioned purse with small objects inside is called a 'fairy purse' and we presume that the small objects represent the fairies' cash."‡

Synopsis of the Genera of the Nidulariaceae

Sporangioles attached to the inner wall of the peridium.

Peridium composed of three layers; spores mixed with filaments. I. CYATHIA.

* Most of what follows in this paragraph is translated and adapted from Tulasne's monograph, pages 54-56, as several of the works referred to were unfortunately unobtainable.

† Ray, Syn. Ed. 3, 2: 20. 1724.

‡ Friend, Flower Lore, 34. 1889.

Peridium composed of one homogeneous layer ; spores not mixed with filaments.

II. CRUCIBULUM.

Sporangioles not attached to the inner wall of the peridium.

Peridium thick, opening by a regular definite mouth.

III. NIDULA.

Peridium thin, rupturing irregularly.

IV. GRANULARIA.

I. CYATHIA P. Br., Civ. and Nat. Hist. Jamaica, 78. 1756

Cyathus Hall. Stirp. Helvet. 3 : 127. 1768

Peridium composed of three distinct but closely connected layers. Mouth at first closed by a membrane (epiphragm), usually white, opening at maturity ; sporangioles flattened, umbilicate beneath, attached to the inner wall of the peridium by a complex elastic cord (funiculus), and with thick horny filaments intermixed with the spores.

Clusius,* in 1601, made the first mention of a *Cyathia* under the name of fungus minimus *ανώνυμος*, and described it in Latin, the following being a free translation of the entire paragraph : " Moreover this fungus, which I will call anonymous, is very different from the preceding ones, and I consider it to be the smallest of all, for it is barely half an inch high. In the fall a great many grow, without petiole, on wooden boards away from dust and sand. They have the color of cinders or are of a lifeless color. The shape, which is so small, appears to be undeveloped, scarcely as large and as thick as the top of a little finger. Sometimes they grow alone or when in numbers two, three or four adhering together, and when ripe, they throw off the top part and appear full of a viscous juice, and of seeds which are about the size of the seeds of cyclamen, but have the outline of small fungi and are apparently cinder-colored. There is no doubt that this fungus grows in Italy, for I remember that a friend of mine sent me, once upon a time from there, some of these seeds, dried and with a certain strange name, asking me if I could find out what they were. For there are certain characters who endeavor to catch and buy praise from the ignorance of others."

There seem to be no intermediate references to this plant until 1671, when Bauhin † mentioned " Fungus minimus lignelis tabellis areolarum hortorum adnascens." Mentzel, ‡ in 1682 first figured

* Rar. Plant. Hist. cclxxxvii. 1601.

† Pinax, Lib. X., Sec. 5, no. 39, 374. 1671.

‡ Ind. Nom. Plant. Univ. pl. 6. 1682.

a plant which was, without doubt, *Cyathia lentifera*. Loeselius,* and Marsilius,† made passing references to this same species, and in 1729 Micheli‡ described and figured two species, citing one from the above-mentioned writers, and the second from Ray,§ Dillenius|| and Vaillant,¶ the latter species being unquestionably *Cyathia striata*. Linnaeus,** in 1753, gives under his section "Acaules" of the genus *Peziza*—*Peziza campanulata lentifera*, first referring to Hortus Cliffortianus (1737) where we find that the only species of *Peziza* which he gives, and to which he refers what is evidently a *Cyathia* is not a *Peziza* in the modern sense, but the first known type of *Cyathia*; and the only proof that he knew what a *Peziza* really was, is his reference to Dillenius'†† work published in 1719, in which a true *Peziza* is figured. Dillenius divided the *Pezisae* into two sections: (1) *Membranacei et tenuiores*—the true *Pezisae*, and (2) *Duriores calyciformes, seminferi putati*, under which head he gives *Peziza calyciformis lentifera lacvis* (our *Cyathia lentifera*) and *Peziza calyciformis lentifera hirsuta* (our *Cyathia hirsuta*).

The genus *Cyathus* was founded in 1768 by Haller, twelve years after *Cyathia* P. Br., and since that time many species have been described from nearly all parts of the world. Fischer‡‡ states that there are forty-two known species.

From our own country not many species have been described, Schweinitz was the first to mention these plants; in 1818 he named ten species, but not all of them are to be referred to the genus *Cyathia*. In 1869 Berkeley & Curtis§§ described *Cyathus pallidus* from Cuba, also reporting *Cyathus intermedius*, *Cyathus Montagnei*, *Cyathus limbatus*, *Cyathus Poeppigii*, *Cyathus microsporus*, and *Cyathus Lescurii* collected by Wright from the same island. Berkeley,||| in 1873, described from Connecticut, *Cyathus Wrightii*,

* Flor. Prus. 98. 1703.

† Dissert. Gen. Fung. 17. pl. a. 1714.

‡ Nov. Plant. Gen. 222. pl. 102. f. 1, 2. 1729.

§ Syn. 3: 21. 1704.

|| Giss. 196. 1719.

¶ Bot. Paris. 57. pl. 11. f. 4, 5. 1727.

** Sp. Pl. 2: 1180. 1753.

†† l. c.

‡‡ Engler & Prantl, Nat. Pflanzenfam. 11*: 328. 1899.

§§ Jour. Linn. Soc. 10: 346. 1869.

||| Grevillea, 2: 34. 1873.

which has not since been reported. *Cyathus rufipes* was described in 1897 by Ellis & Everhart* from Kansas, and the next year Hennings, † described *Cyathus nivcotomentosus* from California.

The following summary will show the distribution of the known species of *Cyathia*:

EUROPE, 7 species: *C. complanata*, *C. deformis*, *C. fimetaria*, *C. hirsuta*, *C. lentifera*, *C. subiculosa*, *C. umbrina*.

ASIA, 6 species: *C. emodensis*, *C. Hookeri*, *C. intermedia*, *C. minima*, *C. Montagnei*, *C. sulcata*.

AFRICA, 5 species: *C. affinis*, *C. dasypus*, *C. pallida*, *C. hirsuta*, *C. lentifera*.

AUSTRALIA, 9 species: *C. Baileyi*, *C. desertorum*, *C. fimicola*, *C. intermedia*, *C. stercorea*, *C. Montagnei*, *C. pezizoides*, *C. pusio*, *C. lentifera*.

NEW ZEALAND, 3 species: *C. Colensoi*, *C. Novae-Zelandiae*, *C. similis*.

NORTH AMERICA, 11 species: *C. intermedia*, *C. lentifera*, *C. melanosperma*, *C. Berkleyana*, *C. rugisperma*, *C. rufipes*, *C. hirsuta*, *C. stercorea*, *C. pallida*, *C. Wrightii*, *C. fragilis*.

CUBA, 7 species: *C. intermedia*, *C. Montagnei*, *C. pallida*, *C. limbata*, *C. Poeppigii*, *C. Berkleyana*, *C. stercorea*.

SOUTH AMERICA, 12 species: *C. ambigua*, *C. dasypus*, *C. limbata*, *C. microspora*, *C. Montagnei*, *C. plicata*, *C. Poeppigii*, *C. Puiggarii*, *C. scutellaris*, *C. hirsuta*, *C. lentifera*, *C. Gayana*.

Synopsis of the Species of *Cyathia*

Peridium sulcate-striate within.

Spores large, more than 35μ long.

1. *C. Poeppigii*.

Spores small, less than 8μ long.

2. *C. Berkleyana*.

Spores of medium size, $12-20\mu$ long.

Peridium sparingly clothed with short fasciculate hairs without.

3. *C. intermedia*.

Peridium thin, shaggy-tomentose without.

4. *C. hirsuta*.

Peridium very tough and brittle, rough tomentose.

5. *C. dura*.

Peridium faintly striate near the mouth, not sulcate within.

6. *C. Montagnei*.

Peridium smooth within, not sulcate.

Spores large, more than 40μ long.

7. *C. melanosperma*.

Spores small, less than 15μ long.

Sporangioles darkish; margin of peridium straight.

Peridium smooth or nearly so.

8. *C. pallida*.

Peridium strigose-tomentose.

9. *C. rugisperma*.

Sporangioles light colored; margin of peridium often recurved.

10. *C. lentifera*.

Spores of medium size, $15-30\mu$ long.

Peridium with a red felt-like mycelial bulb at base.

11. *C. rufipes*.

Peridium with a thick bulb of whitish mycelium.

12. *C. Wrightii*.

Peridium scarcely thickened at the base.

13. *C. stercorea*.

* Bull. Torrey Club, 24: 125. 1897.

† Hedwigia, 37: 274. 1898.

1. *Cyathia Poeppigii* (Tul.)

Cyathus Poeppigii Tul. Ann. Sci. Nat. III. 1: 77. pl. 4. f. 23-25; pl. 5. f. 3-4. 1844.

Peridia slender, goblet-shaped, 7-12 mm. high, 5-7 mm. wide at the top, about 1 mm. at the base of the stem, dark chocolate-brown, the outer surface somewhat shaggy, peeling, leaving a comparatively smooth, deeply and closely striated surface, corresponding with the deep inner striations, the inner surface brown, somewhat lighter colored than the outer surface, somewhat shiny, deeply striate; mouth minutely fimbriate; sporangioles blackish, flattened, dull, 2-2.5 mm. in diameter; funiculus long; spores 38-45 μ long, 18-22 μ in diameter, very thick-walled, granular within, oblong and often slightly curved. (Pl. 14. f. 1-4.)

Growing singly and in groups on manure and wet ground.

ST. CROIX (Danish West Indies): A. E. Ricksecker.

This species was originally described from Cuba and French Guiana; it is easily distinguished from the other striated species of *Cyathia* by its unusually large spores, and by its deeply and closely striated outer surface.

2. *Cyathia Berkleyana* (Tul.)

Cyathus microsporus β *Berkleyanus* Tul. Ann. Sci. Nat. III. 1: 74. 1844.

Peridia small, cup-shaped, 5-8 mm. high, 5-7 mm. wide at the top, very much narrowed and rounded at the base, brownish outside and somewhat shaggy; mouth finely fimbriate, the inner surface of the peridium shiny, grayish-brown, lighter colored than the outer, coarsely striate; sporangioles small, 2 mm. in diameter, shiny, nearly black, flattened; spores small, 6-8 μ long, 4-6 μ wide, somewhat thick-walled, hyaline. (Pl. 14. f. 5-7.)

On decayed stems of coarse herbaceous plants.

JAMAICA: Cockerell.

This species was originally described from Brazil; it somewhat resembles small specimens of *Cyathia hirsuta*, but it differs from that species in the texture of the outer coat, which is much less shaggy and thick, and in the much smaller spores.

3. *Cyathia intermedia* (Mont.)

Nidularia intermedia Mont.; Sagra, Hist. Phy. Pol. Cuba, 321. 1838-42.

Cyathus intermedius (Mont.) Tul. Ann. Sci. Nat. III. 1: 72.
pl. 4. f. 4-7. 1844.

Peridia cup-shaped, not rounded at the base, 7-9 mm. high, 6-8 mm. wide at the top, 1-2 mm. at the base, lightish brown, clothed with fine hairs which grow in clusters, the tips of several of which join together in little outwardly curved tufts, thin and showing the inner sulcate markings through in the older peridia; inner surface brown, shiny, sulcate-striate; the mouth straight, not flaring, clothed with a circle of short stiff bristles; the sporangioles about 2 mm. in diameter, flattened, blackish, depressed beneath, somewhat angular with a short attachment; spores hyaline, 12-18 μ long, 6-9 μ wide, thick-walled. (*Pl. 14. f. 8-10; pl. 18. f. 18.*)

Growing in loose soil and on decaying wood.

[CUBA: *Ramon de la Sagra.*]

DELAWARE: Faulkland, *Commons.*

This species was originally described from Cuba; it differs from *Cyathia hirsuta* in the character of the tomentose outer covering of the peridium, and in the shorter and more rudimentary attachment of the sporangioles to the inner peridial wall.

4. *Cyathia hirsuta* (Schaeff.)

Peziza lentifera β Linn. Sp. Pl. 2: 1180. 1753.

Peziza sessilis campanulata villosa Scop. Fl. Carn. 57. 1760.

Peziza prima Schaeff. Fung. Bav. et Palat. Icon. 2: *pl. 178.*
 1763.

Cyathus hirsutus intus striatus Hall. Stirp. Helvet. 3: 127. 1768.

Peziza cyathiformis Scop. *p. p.** Fl. Carn. 2: 486. 1772.
 [Ed. 2.]

Peziza hirsuta Schaeff. Fung. Bav. et Palat. 4: 124. 1774.

Peziza striata Huds. Flor. Ang. 634. 1778. [Ed. 2.]

Peziza hirsuta Batsch, Elench. Fung. 127. 1783.

Nidularia striata With. Bot. Arrang. 3: 446. 1792 [Ed. 2];
 Sibth. Fl. Ox. 393. 1794; Fries. Syst. Mycol. 3: 298. 1822;
 Schwein. Trans. Amer. Phil. Soc. 4: 252. 1834.

Cyathus striatus Willd. Fl. Berol. 399. 1787; Hoffm. Veg.
 Crypt. fasc. 2: 33. *pl. 8. f. 3.* 1790; Pers. Syn. Meth. Fung. 237.
 1801; Nees, Syst. 140. 1817; DC. Fl. Fr. 2: 269. 1805; Tul.
 Ann. Sci. Nat. III. 1: 67. 1844.

* As the first cited reference under the description of this species belongs to *C. lentifera* this name cannot be taken up for this species.

Peridia 10-15 mm. high, 8-10 mm. wide at the top, 2-4 mm. at the base, usually straight trumpet-shaped, very gradually spreading toward the top; outer surface of the peridium dark brown, shaggy fibrillose; inner surface brown or grayish-brown, shiny, striate-sulcate for about one half the height of the peridium, becoming smooth at the base; mouth densely clothed with a circle of stiff regular bristles; sporangioles darkish, 2 mm. in diameter, shiny, depressed beneath, and somewhat angular from the pressure of one upon the other; spores 12-18 μ long, 6-9 μ wide, thick-walled, hyaline, somewhat crescent-shaped. (*Pl. 14. f. 11-14; pl. 18. f. 1-6.*)

Growing singly and in clusters, on sticks, bark, etc.

EXSICC.: Ellis, North American Fungi, 729.

NEW YORK: *Underwood, Tooke, Clinton, Brown, Merrill*; MAINE: *Harvey*; CONNECTICUT: *White*; PENNSYLVANIA: *Gentry, Lloyd*; OHIO: *Lloyd, James*; GEORGIA: *Underwood*; ALABAMA: *Earle*; IOWA: *Langlois*; WISCONSIN: *Williams*; INDIANA: *Underwood*; MONTANA: *Anderson, no. 601*; COLORADO: *Bethel*; WASHINGTON: *Suksdorf*; CANADA: *Dearnass*; PUERTO RICO: *Underwood & Griggs*; MEXICO: *Egeling*.

Tulasne* has given an account of the development of this species from which the following is freely translated:

The young plants arise on the thick felt-like mycelium in the shape of small cylindrical jelly-like masses. They are at first white and smooth, gradually changing to a brown color and their surface becomes somewhat scaly. The three coats which compose the peridium are indicated at this stage, when the outer brownish scaly portion begins to form itself into the outer coat, while the walls of the white glutinous inner substance become differentiated from the fruiting portion into a very thin membrane which encloses these parts, a thin portion of the glutinous membrane remaining between these two coats welding them together and so forming the triple peridial wall. It is now that the sporangioles begin their growth, gradually absorbing the surrounding substance into themselves, so that when the plant is mature and gradually opens, the sporangioles alone remain within the cup attached to the sides of the peridium by means of a funiculus of a complicated structure. The sporangioles are in most

* Ann. Sci. Nat. III. 1: 50-54. *pl. 3; pl. 4. f. 1-3; pl. 8. f. 1-12.* 1844.

cases composed of three parts, namely, of a thick and usually dark colored coat, a light hyaline thickly interwoven portion which bears the basidia, which in their turn bear the spores. The center part is composed of innumerable spores mixed with branching filaments. The walls of the spores are very thick, these spores having long been separated from their basidia. The funiculus is composed of three parts; the lower portion is variable as to length and thickness, its lower extremity is expanded and attached to the peridium; the upper portion is more regular in shape and is attached by its upper extremity to the sporangiole; it is rather swollen in the center, in which portion there is enclosed a long and slender filet composed of innumerable hyaline, interwoven filaments, which can be drawn out if great care is used in the process and forcibly distended without breaking, according to Tulasne to a length of 12 cm. These two parts are joined by a much narrower and shorter portion to which Tulasne gives the name of "filet médian."

4a. *CYATHIA HIRSUTA* **infundibuliformis** var. nov.

Peridia 1.5–18 cm. high, funnel-shaped, 1–2 cm. wide at the top, 1.5–2 mm. at the base, 4–5 mm. in the center where the peridium is contracted; outer surface of the peridium brownish, coarsely shaggy-tomentose; inner surface dull brownish, clearly striate, but not below the contraction; mouth minutely fimbriated; sporangioles dull brownish, 2 mm. in diameter, flattened; spores 8–12 μ wide, 14–17 μ long, thick-walled, hyaline. (*Pl. 14. f. 15.*)

Growing singly on leaves and moss.

MONTANA: Sheridan, *Fitch*.

This variety differs from the type in the definite funnel-shape of the peridium, and in the nature of the tomentum, and to a less degree in the size of the spores. Further material may necessitate a different treatment.

5. *Cyathia dura* sp. nov.

Peridia flaring trumpet-shaped, 8–13 mm. high, 8–12 mm. wide at the top, 2–4 mm. at the base, brownish-gray outside, rough, shaggy, and very tough and brittle; inner surface whitish, dull, and marked with rather wide shallow striations; mouth recurved, ragged and much split, but not fimbriate; bases of the peridium contracted and in some specimens there is a thick felty

brown mycelial band adhering; sporangioles dull grayish, oval or rounded, 2.5 mm. long, 1.5 mm. wide; spores 14–18 μ long, 8–10 μ wide, hyaline and thick-walled. (*Pl. 14. f. 16–19.*)

COLORADO: Denver, *Bethel*, 8.

This species differs from all others seen in the character of the peridium, which is very thick, hard and brittle.

6. *Cyathia Montagnei* (Tul.)

Cyathus Montagnei Tul. Ann. Sci. Nat. III. 1: 70. *pl. 4, f. 9–11.* 1844.

Peridia 8–10 mm. high, 6–9 mm. wide at the top, 2–3 mm. at the base, spreading, cup-shaped, reddish-brown outside, closely woolly-tomentose, but not shaggy, rather thin; inner surface grayish, dull, faintly striate close to the top, not sulcate; mouth at first curved inwards, then straight, but not recurved, closely and very minutely fimbriate; sporangioles 2 mm. in diameter, grayish, black, somewhat lighter beneath, dull, flattened, angular; spores 15–18 μ long, 8–12 μ wide, thick-walled, granular, hyaline. (*Pl. 14. f. 20–22.*)

On the ground and on decaying wood and chips.

YUCATAN: *C. F. Mills* *paugh*, 787; [CUBA].

This species was originally described from Brazil; it is readily distinguished from the preceding species: (1) By the faint and only partial striae of the upper part of the inner surface of the peridium, and (2) By the woolly tomentose, and not shaggy nature of the outer coat.

7. *Cyathia melanosperma* (Schwein.)

Nidularia melanosperma Schwein. Trans. Am. Phil. Soc. 4: 253. 1834.

Cyathus melanospermus (Schwein.) De Toni; Saccardo, Syll. Fung. 7: 42. 1887.

Peridia cup-shaped, clustered, 5–7 mm. high, 5–6 mm. wide at the top; the outer surface brownish and very shaggy; the inner surface smooth, shiny, dark gray; mouth straight and slightly fimbriate; sporangioles black, flattened, about 2 mm. wide; spores large, 45–55 μ long, 18–45 μ wide, very thick-walled, granular within, hyaline. (*Pl. 15. f. 1–4.*)

Gregarious on the earth.

PENNSYLVANIA: Bethlehem, *Schweinitz*.

The above description is based on Schweinitz's original speci-

mens, which are still in good condition at the Philadelphia Academy of Sciences. This appears to be a rare species, as it is known only from its original collection. It differs from all the following species of *Cyathia*, which have a smooth inner surface, in having a fimbriate mouth, though Schweinitz in his original description notes that it has a smooth mouth, but he writes that *Nidularia stercorea* has a fimbriate mouth, which is contradicted by his own specimens.

8. *Cyathia pallida* (B. & C.)

Cyathus pallidus B. & C. Jour. Linn. Soc. 10 : 346. 1869.

Peridia 4–8 mm. high, 5–7 mm. wide at the top, about 2 mm. at the base, slender urn-shaped, slightly expanded at the top and contracted at the base, thin and membranous, fawn-colored outside, and minutely shaggy; inner surface light lead-colored, smooth, shiny; mouth entire or torn but not fimbriate, sometimes slightly striated; sporangioles 2 mm. in diameter, flattened, the edges very thin, and thicker in the middle, darker above than below, shiny as if frosted, and under high magnification showing a network of delicate rugose wrinkles; spores 5–9 μ long, 5–7 μ wide, hyaline, thick-walled, oval-pointed or nearly round, pale yellow in the mass. (*Pl. 15. f. 5–7.*)

Growing on decayed wood.

CUBA : *Wright*; PUERTO RICO : Coamo Springs, *Underwood & Griggs*.

The above description is based on the co-types of this species in the Curtis collection at Harvard University.

9. *Cyathia rugisperma* (Schwein.)

Nidularia rugisperma Schwein. Trans. Am. Phil. Soc. 4 : 253. 1834.

Cyathus rugispermus (Schwein.) De Toni ; Saccardo, Syll. Fung. 7 : 42. 1888.

Peridia somewhat obconic, sharply contracted at the base, 5–8 mm. high, 4 mm. wide at the top; outer surface lightish fawn-colored, strigose-tomentose, becoming nearly smooth when mature; inner surface darkish brown, smooth, and shiny; mouth incurved in the young peridia, and completely covered by the tomentose outer covering; sporangioles black, flattened, roundish, 1–1.5 mm. in diameter; spores 10–14 μ long, 8–10 μ wide, somewhat granular and thick-walled, hyaline. (*Pl. 16. f. 3–6.*)

Growing singly on bits of shaving and fibrous matter.

PENNSYLVANIA : Bethlehem, *Schweinitz*.

The above description is based on the original specimens. Schweinitz, in his description of this species, says: "Sporangiiis non nitentibus, sed superficie reticulato-rugosa," but no such markings were noticeable.

This is a pretty little species, and is known only from its original collection.

10. *Cyathia lentifera* (L.)

Peziza lentifera a. Linn. Sp. Pl. 2: 1180. 1753.

Peziza sessilis campanulata laevis Scop. Fl. Carn. 57. 1760.

Peziza tertia Schaeff. Fung. Bav. et Palat. Icon. 2: pl. 180. 1763.

Cyathus sericeus intus laevis Hall. Stirp. Helvet. 3: 127. 1768.

Peziza cyathiformis Scop. p. p. Fl. Carn. 2: 486. 1772 [Ed. 2].

Peziza sericea Schaeff. Fung. Bav. et Palat. 4: 125. 1774.

Peziza lentifera Huds. Fl. Ang. 2: 633. 1778 [Ed. 2].

Peziza Olla Batsch, Elench. Fung. 127. 1783.

Nidularia vernicosa Bull. Champ. 1: 164. pl. 488. f. 1. 1791.

Cyathus laevis Hoffm. Veg. Crypt. fasc. 2: 31. pl. 8. f. 2. 1792.

Coccigrue à lentilles Paulet. Tr. des Champ. 2: 406. pl. 187. f. 7-12. 1793.

Nidularia campanulata With. Bot. Arrang. 3: 445. 1792 [Ed. 2]; Sibth. Fl. Ox. 393. 1794; Fries, Syst. Myc. 2: 298. 1822.

Cyathus Olla Pers. Syn. Meth. Fung. 237. 1801.

Cyathus vernicosus DC. Fl. Fr. 2: 270. 1805; Tul. Ann. Sci. Nat. III. 1: 81. pl. 5. f. 14-23. 1844.

Nidularia plumbea Pers. Champ. Comest. 110. 1818.

Nidularia fascicularis Schwein. Trans. Am. Phil. Soc. 4: 253. 1834.

Cyathus campanulatus Corda, Anleit. lxxx. pl. D. f. 42 (19-23). 1842.

Peridia 8-12 mm. high, 5-15 mm. wide at the top, 2-7 mm. at the base, campanulate, the edge often recurved and expanded; outer surface lightish-brown or grayish-yellow, almost smooth, sometimes having a few tow-like fibers attached which give it a slightly roughened appearance; inner surface smooth, whitish or lead-colored, shiny; mouth entire, often ragged and split; sporangioles light-colored, 2-3 mm. in diameter, flattened beneath; spores 8-15 μ long, 6-10 μ wide, thick-walled, hyaline. (Pl. 15. f. 8-13.)

Plants sessile, or sometimes stalked, growing singly or in clusters on the earth, on dry chips, twigs, etc.

NEW YORK: *Underwood*; MAINE: *Harvey, Bartle*; CONNECTICUT: *White*; PENNSYLVANIA: *Martin*; ALABAMA: *Earle*; INDIANA: *Underwood*; KANSAS: *Bartholomew, 1032*; COLORADO: *Ravenel*; UTAH: *Harkness*; CALIFORNIA: *Orcutt, Baker*; TEXAS: *Young*; PUERTO RICO: *Goll*.

11. *Cyathia rufipes* (Ell. & Ev.)

Cyathus rufipes Ell. & Ev. Bull. Torrey Club, **24**: 125. 1897.

Peridia very slender, obconic, .8–1.5 cm. high, 3–6 mm. wide at the top, 1–1.5 mm. at the base, outer surface lightish brown or tow-colored, very shaggy tomentose, and with a quantity of reddish-brown mycelium adhering at the base, forming a felt-like tuft; inner surface smooth, dark gray, shiny; sporangioles 2 mm. in diameter, dark, almost black, shiny, depressed beneath; spores 25–29 μ long, 18–22 μ wide, thick-walled, granular within and hyaline. (*Pl. 15. f. 14–16.*)

On old sods, "growing head downward."

KANSAS: *Bartholomew*; NEBRASKA: *Bates*.

This species is readily distinguished from the other species of *Cyathus* with a smooth inner surface by its very slender elongated shape and its light densely tomentose peridium, besides the characteristic feature of the red felt-like mycelial tuft at the base, from which the species derives its name.

12. *Cyathia Wrightii* (Berk.)

Cyathus Wrightii Berk. Grevillea, **2**: 34. 1873.

Peridia rather large, cup-shaped, 1.2–1.8 cm. high, .5–1.2 cm. wide at the top, contracted somewhat at the base, then bulbous, the bulb composed of mycelium and adhering earth; outer surface darkish brown, very rough, shaggy and encrusted with earth; inner surface smooth, shiny, darkish; mouth entire, not fimbriate though the fine hairs circle up about it; sporangioles dark, 1.5–2 mm. in diameter, shiny, flattened; spores 22–25 μ long, 15–18 μ wide. (*Pl. 16. f. 7–9.*)

CONNECTICUT: Growing singly on earth, *C. Wright*.

This species is not known to have been reported since the original collection. The above description of external characters is based on the cotypes at Harvard University. The spores were

not seen; the measurement being taken from some mss. notes on *Cyathus* by Masee, made from the type of *C. Wrightii* at Kew. De Toni gives the measurement in Saccardo as "15 μ long by 10 μ wide."

13. *Cyathia stercorea* (Schwein.)

Nidularia stercorea Schweinitz, Trans. Am. Phil. Soc. 4: 253. 1834.

Cyathus Lesueurii Tul. Ann. Sci. Nat. III. 1: 79. pl. 5. f. 5-13. 1844.

Cyathus Lesueurii, var. *minor* Tul. l. c. 80.

Cyathus stercoreus (Schwein.) De Toni; Saccardo, Syll. Fung. 7: 40. 1888.

Peridia slender, campanulate, sessile or with an elongated slender base, .5-1.5 cm. high, 4-8 mm. wide at the top, 1-3 mm. at the base; outer surface brownish fawn-colored, the young plants being strigose with a copious covering of shaggy hairs, which gradually disappear, leaving the mature peridium almost smooth, or marked with circular depressed zones; inner surface smooth, shiny, lead-colored, somewhat darker toward the base; the mouth entire or at first appearing fimbriate from the surrounding hairy covering, but not ciliate-fimbriate; sporangioles blackish-lead-colored, smooth, shiny, 2 mm. in diameter, depressed beneath; spores 25-30 μ long, 20-25 μ wide, thick-walled, hyaline, granular within. (Pl. 15. f. 17-20; pl. 16. f. 1, 2.)

Growing on manure, bits of wood, etc.

EXSICC.: E. & E. Fungi Columbiani, 644 (as *Cyathus vernicosus*); Ravenel, Fungi Amer. Exsic. 473 (as *Cyathus vernicosus*), 474 (as *Cyathus Lesueurii*); Ravenel, Fungi Car. Exsic. 3: 73 (as *Cyathus campanulatus*); Ellis, N. A. Fungi, 1308 (*Cyathus vernicosus*); Shear, N. Y. Fungi, 316.

PENNSYLVANIA: Schweinitz; NEW YORK: Underwood, Shear, Brown, Vail; MASSACHUSETTS: Ellis, Knight; MAINE: Harvey; NEW JERSEY: Ellis; DELAWARE: O. S.; SOUTH CAROLINA: Ravenel; VIRGINIA: Merrill; IOWA: Langlois; INDIANA: Underwood, Arthur; OHIO: Morgan, Lloyd; ALABAMA: F. S. Earle & C. F. Baker, Tuskegee, Carver; KANSAS: Cragin, 273; COLORADO: Baker; NEBRASKA: Williams; NEW MEXICO: F. S. Earle & E. S. Earle Cockerell; CANADA: Dearness, 1149.

This species varies very much as to size, shape and smoothness of the peridium, which facts have been rather misleading, but

such different types have been found in specimens from one locality from the short, strigose, sessile or bulbous form to the slender, almost smooth, elongated form—that there can be no question as to their being in reality but one species. Tulasne does not mention Schweinitz's *Nidularia stercoræ*, and his species *Cyathus Lescurii* from New Orleans was presumably described without knowledge of the preceding species. His variety *Cyathus Lescurii* var. *minor* from Carolina, closely resembles small forms of *Cyathia stercoræ*.

CYATHIA (?) sp.

Peridia cup-shaped, clustered, 4–6 mm. high, 3–5 mm. wide at the top, 2 mm. at the base; outer surface lightish brown, nearly smooth, or minutely fibrous; inner surface smooth, very dark brown, almost black, shiny; mouth entire or slightly ragged, but not fimbriate; sporangioles black, shiny, angular beneath, rounded above, 1 mm. in diameter, showing no trace of any attachment, numerous; spores 20–30 μ long, 18–24 μ wide, thick-walled, granular within, hyaline. (*Pl. 16. f. 16, 21, 22.*)

No mention as to habitat.

The specimens on which the above description is based were sent to Mr. Ellis by Professor E. Bethel (no. 9) from Denver, Colorado, and were named *Cyathus vernicosus*. They consist of four or five groups of from two to five plants in each. The peridial wall is triple and the structure of the sporangioles is much as in *Cyathia*, the spores being also intermixed with thick horny filaments as in that genus; but there is no trace whatever of any attachment either on the under surface of the sporangioles or on the inner surface of the peridium. The specimens are all mature, so it is impossible to know what the nature of the young peridia was, but the sporangioles are still in the peridia, filling them completely, even with the margin quite unlike anything seen belonging to the genus *Cyathia*. It is very possible that a genus standing in the same relation to *Cyathia*, as *Nidula* does to *Crucibulum*, will eventually have to be established to accommodate these forms, but the material and data are not sufficient to justify taking such a step at present.

SPECIES INQUIRENDA

CYATHUS NIVEO-TOMENTOSUS P. Henn. Hedwigia, **37**: 274. 1898

Sparsis: peridio obconico-cyathiformi, crassiusculo papyraceo primo operculo albo tecto, sessili vel substipitato, extus niveo

sericeo, dense tomentoso, margine integro, crasso, 3-5 mm. alto, 4-5 mm. lato, intus albo-flavescente; sporangiolis innumeris, lentiformibus, planis, tenue tunicatis, cinnamomeis, sericeis, 1-1.2 mm. diametro; sporis ellipsoideis, obtusis, intus granulatis, hyalinis, $7-8.5 \times 4.5-5.5 \mu$, episporio hyalino, tenui, levi.

CALIFORNIA: Potter Valley. On decaying wood (Sept. 1894).
Purpus.

The original description is quoted, as no specimens of this species were seen, and until more material has been collected it is difficult to decide with any degree of certainty just where it belongs. The author adds that this species appears to be related to *Cyathia pallida*.

II. CRUCIBULUM Tul. Ann. Sci. Nat. III. 1: 89. 1844

Peridium composed of a single, homogeneous, though sometimes layered, felt-like membrane, which is at first continuous over the mouth, forming a sort of epiphragm; sporangioles more numerous than in the preceding genus, and the funiculus is much less complex, consisting of a little bundle of elastic filaments gathered closely together in a very thin, hardly noticeable outer covering, the upper end of which is attached to a nipple-like protuberance on the under surface of the sporangiole, and the lower end is attached to the inner wall of the peridium; there are no filaments intermixed with the spores.

Although the genus *Crucibulum* was not founded until 1844, for nearly a century and a half plants belonging to it have been known and unmistakably figured. Ray* in 1696, in a list of plants collected by D. Samuel Doody, mentions "Fungus seminifer minor," which he figured in 1724.† Micheli, five years later, gave a good figure of *Crucibulum crucibuliforme*. As early as 1697 Boccone‡ figured this plant, under the name of "Fungus $\sigma\pi\epsilon\rho\mu\alpha\tau\iota\alpha\varsigma$ calyculatus," but does not seem to give it more than this passing notice. Gleditsch,§ Schaeffer,|| Scopoli,¶ Hudson,** Hoffman†† and others made mention of this plant, under various names, but

*Syn. 333. 1696. [Ed. 2.]

†Ray, Syn. 20. *pl. 1. f. 2 b, c.* 1724. [Ed. 3.]

‡Mus. Fis. *pl. 301. f. 1.* 1697.

§Meth. Fung. 138. *pl. 4.* 1753.

||Fung. Bav. et Palat. Icon. 2: *pl. 179.* 1761; 4: 125. 1774.

¶Flor. Carn. 2: 486. 1772. [Ed. 2.]

**Flor. Ang. 2: 634. 1778. [Ed. 2.]

††Vegt. Crypt. fasc. 2: 29. *pl. 8. f. 1.* 1790.

not until 1801, was the present generic name employed by Persoon*—even then only to denote a species—*Cyathus Crucibulum*.

Schweinitz was the first to report *Crucibulum crucibuliforme* from this country under the name of *Nidularia Crucibulum*. He also described another species, *Nidularia juglandicola* which though retained as a good species of *Crucibulum* by De Toni,† proves to be a form of *Crucibulum crucibuliforme*, slightly larger and more flaring, but otherwise similar to the type species. Though the genus as represented by *Crucibulum crucibuliforme* is comparatively common and widely distributed, it is interesting to note in contrast with the genus *Cyathia*, which is very prolific of species, that only one other species has been described, viz., *Crucibulum simile* Massee‡ from New Zealand and Australia, and even this is said to resemble *Crucibulum crucibuliforme* closely.

Bulliard§ says that there are two varieties of *Crucibulum* both of which he figures, one glabrous, almost as smooth inside as out, the other smooth inside but somewhat tomentose on the outside, and always larger and more yellow than the first. It has been noticed in examining quite a number of specimens from different localities that those collected in one place often vary greatly in size and color, and in the nature of the tomentose outer surface of the peridium. Cooke,|| in 1879, described a variety which he calls *lanosum*, and which De Toni says might possibly be Bulliard's second variety (figured on *pl.* 40) but as Cooke described it as "paler than in the usual form" this disposition cannot be correct.

1. *Crucibulum crucibuliforme* (Scop.)

Peziza sessilis campanulata (b) Gled. Meth. Fung. 138. *pl.* 4. 1753.

Peziza secunda Schaeff. Fung. Bav. et. Palat. Icon. 2 : *pl.* 179. 1763.

Peziza lentifera Oeder, Fl. Dan. 2 : 9. *pl.* 105. 1763; not Linnaeus.

Peziza crucibuliformis Scop. Flor. Carn. 2 : 486. 1772 [Ed. 2]; Schaeff. Fung. Bav. et Palat. 4 : 125. 1774.

*Syn. Meth. Fung. 239. 1801.

†Saccardo, Syll. Fung. 7 : 44. 1888.

‡Grevillea, 19 : 93. 1891.

§Champ. 1 : 165. *pl.* 40 and *pl.* 488. 1809.

||Grevillea, 8 : 58. 1879.

Peziza laevis Huds. Fl. Ang. 634. 1778. [Ed. 2.]

Cyathus cylindricus Willd. Fl. Berol. 399. 1787.

Cyathus crucibuliformis Hoffm. Veg. Crypt. fasc. 2, 29. pl. 8. f. 1. 1790.

Nidularia laevis Bull. Champ. 1: 164. pl. 448. f. 2. pl. 40. 1791; With. Bot. Arrang. 3: 446. 1792 [Ed. 2]; Sibth. Fl. Ox. 393. 1794.

Cyathus Crucibulum Pers. Syn. Fung. 238. 1801; Nees, Syst. 140. pl. 13. f. 133. 1817.

Cyathus laevis DC. Fl. Fr. 2: 269. 1805.

Nidularia Crucibulum Secret. Mycogr. Suisse, 3: 378. 1833; Schwein. Trans. Am. Phil. Soc. 4: 253. 1834.

Nidularia juglandicola Schwein. Trans. Am. Phil. Soc. 4: 253. 1834.

Crucibulum vulgare Tul. Ann. Sci. Nat. III. 1: 90. pl. 6. f. 9-24. pl. 7. f. 1. pl. 8. f. 13-17. 1844.

Crucibulum juglandicolum De Toni; Sacc. Syll. Fung. 7: 44. 1888.

Peridia 5-10 mm. high, 5-10 mm. across at the top, 4-7 mm. at the base, cylindrical-campanulate, base truncate or but slightly contracted; outer surface dirty cinnamon or grayish fawn-color, young plant minutely velvety tomentose, becoming smoother with age; the inner surface smooth, shiny and whitish; mouth entire, firm and even, sometimes slightly contracted, sporangioles pale ochraceous, becoming whitish, 1.5-2 mm. in diameter, very numerous and crowded, flattened beneath; spores hyaline, elliptic, 8-10 μ long, 4-6 μ wide, smooth, some thick-walled. (Pl. 16. f. 10-15; pl. 18. f. 7-13 and 16.)

Plants gregarious or single on twigs, old bagging, chips, etc.; common and variable.

EXSIC.: Ellis, N. A. Fungi, no. 728; Ravenel, Fungi Amer. Exsic. no. 139.

NEW YORK: *Underwood*, *Clinton*, *Jelliffe*; MAINE: *Harvey*; CONNECTICUT: *Underwood*, *White*; MASSACHUSETTS: *Underwood*, *Underwood & Seymour*, 941; NEW JERSEY: *Ellis*, *White*; PENNSYLVANIA: *Haines*, *Everhart*; ALABAMA: *Underwood*, *Earle*; VIRGINIA: *Underwood*; KENTUCKY: *Underwood*; INDIANA, *Underwood*; KANSAS: *Cragin*, 490; OREGON: *Carpenter*; MONTANA: *Reynolds*; COLORADO: *Bethel*, *Underwood & Selby*; WASHINGTON: *Suksdorf*.

The following is extracted and translated from Tulasne's more extended description of this species: The inner white evanescent pellicle is a remnant of the mucilaginous matter which fills the cup in its early stages. The sporangioles are accumulated in large numbers in a space apparently too small to contain them. They are covered with a thick fibrous coat which can be peeled off, and when deprived of this the sporangiole is black and of a horny consistency. It is composed of two parts, a thick and much interwoven darker outer part, and an inner hyaline portion composed of irregularly shaped filaments taking the place of basidia and forming a hymenium of which the surface is nearly uniform. The rest of the inner substance is composed of the spores without any filaments, which fact distinguishes these sporangioles from some of those belonging to species of *Cyathia*. The funiculus of *Crucibulum* is much more simple than that of *Cyathia hirsuta*, being composed of a little bunch of elastic filaments gathered closely together in a very thin, transparent outer covering, which is hardly noticeable, and of an equal filet, about 2-3 mm. long, which expands itself at the base into the inner wall of the peridium.

III. *Nidula* gen. nov.

Peridium composed of a single homogeneous, but layered membrane which is at first continuous over the mouth much as in *Crucibulum*; sporangioles very numerous, at first immersed in a glutinous substance, very closely packed, entirely filling the central cavity and in no way attached to the peridium wall; no filaments intermixed with the spores.

Peridium shaggy-tomentose; sporangioles light-colored, 2 mm. wide.

1. *N. candida*.

Peridium minutely tomentose; sporangioles dark-colored, barely 1 mm. wide.

2. *N. microcarpa*.

1. *Nidula candida* (Peck)

Nidularia candida Peck, Reg. Rep. 45: 24. 1891.

Peridia 6-15 mm. high, 6-15 mm. wide at the top, 5-10 mm. at the base, cylindrically cup-shaped, somewhat truncate at the base; outer surface white, becoming dingy with age, thick, felt-like, shaggy-tomentose; inner surface smooth, at first snowy white, becoming brownish with age, somewhat shiny; mouth entire, firm, somewhat spreading but not recurved; sporangioles 1.5-2 mm. in diameter, light grayish fawn-colored, very thin, flattened, both sur-

faces perfectly even, angular, but not depressed; spores 6–10 μ long, 4–8 μ wide, globose to elliptic, hyaline, somewhat granular, thin-walled. (Pl. 16. f. 17–20.)

Growing singly on twigs, moss, etc.

WASHINGTON: Olympia, *Henderson, Suksdorf*.

BRITISH COLUMBIA: *Macoun, 1907*.

2. *Nidula microcarpa* Peck, sp. nov.

Peridia 4–6 mm. high, 4–5 mm. wide at the top, 3–5 at the base, subcylindrical; outer surface whitish, or pale grayish-yellow, minutely tomentose, firm; inner surface smooth, with a thin brownish shiny layer formed by the drying of the glutinous inner substance; mouth entire, straight and firm; sporangioles very numerous, lenticular, covered with a thick fibrous outer coat, which peels off, as in *Crucibulum crucibuliforme*, when dry rugosely wrinkled, becoming smooth when moistened, reddish-brown, .5–1 mm. wide; spores 6–9 μ long, 4–6 μ wide, broadly elliptic or subglobose, hyaline, thick-walled. (Pl. 17. f. 1–6; pl. 18. f. 14, 15, 17.)

Growing on wood, and on the ground.

CALIFORNIA: *W. R. Dudley*.

MONTANA: Columbia Falls, *R. S. Williams*.

2a. *NIDULA MICROCARPA rugispora* var. nov.

Crucibulum rugisporum E. & E. in herb.

Peridia 3–5 mm. high, 3–6 mm. wide at the top; outer surface yellowish-white, with a rather thin close tomentum; inner surface smooth, whitish or brownish, somewhat shiny; mouth recurved, and spreading, and minutely lacerate, fimbriate; sporangioles very numerous, reddish-brown, rugose when dry, barely 1 mm. wide, flattened, subrotund; spores broadly elliptic, hyaline, slightly thick-walled, 6–9 μ long, 4–7 μ wide, slightly larger than in the foregoing species. (Pl. 17. f. 7–9.)

Growing on dead twigs.

WASHINGTON: Skamania county, alt. 3,000 ft., *Suksdorf, 510*.

Though this variety closely resembles the species it differs in the mouth characters and in the somewhat larger spores.

IV. GRANULARIA Roth, Ust. Ann. Bot. 1: 6. pl. 1. f. 1. 1791

Nidularia Fries & Nord. Symb. Gaster. 2. 1817–18.

Peridium composed of a single homogeneous rather thin closed membrane, or a thin, closely interwoven layer of branched fila-

ments, opening more or less irregularly by the breaking away or falling to pieces of the walls at maturity, having no true epiphragm: sporangioles enveloped in mucus and not attached in any way to the inner surface of the peridium.

The history of the genus *Granularia*, though not as long as that of the first two genera belonging to this family, appears to have become more involved and complicated, very probably owing to the fact that the species of *Granularia* are as a rule, rarer, and less conspicuous than the species of *Cyathia* and *Crucibulum*. Micheli* in 1729 figured "*Cyathoides scutellatum*," which is unquestionably a true *Granularia*, and the reason why this species has since been placed under *Cyathus* by Roth† and later by Tulasne, it hard to understand. Micheli, in writing of this genus, says "[fructus] vel prope centrum, vel ad circumferentiam brevissimo pediculo seu umbilicali funicolo firmantur," but of the figure of three sporangioles of "*Cyathoides scutellatum*" only one has a short lateral attachment, and that much shorter than in the figures of the sporangioles of the three other species represented. Fries‡ says of his second division, which contains true *Granularia*, that the sporangioles have no umbilicus or umbilical thread, but are attached by the margin. Tulasne writes that notwithstanding these authorities, the lateral position of a funiculus seems very problematical in the genus *Cyathia*, and that the sporangioles of the specimens of *Granularia* which he has studied do not adhere any more by the edge than by any other point, either to the mucilage in which they are immersed or to the peridium. This idea must have arisen from the fact that the mucus contiguous to the walls of the peridium dries up a little quicker than that in the center of the cup and for this reason, several sporangioles appear to be fixed by their outer margin, while they are still loose in the center of the cup. But this does not explain why "*scutellaris*" has been made a species of *Cyathia*.

No other writer seems to have mentioned this plant after Micheli until 1791, when Roth described a new genus *Granularia*, as follows: "Fungus subrotundus, granis mucilagine immersis

* Nov. Pl. Gen. 222. pl. 102. f. 4. 1729.

† Roth, Cat. Bot. 1: 237. 1797.

‡ Syst. Myc. 2: 300. 1822.

farctus," with one species *Granularia pisiformis*, which he fully describes and figures. This is unquestionably a *Nidularia*, as this genus was called until Otto Kuntze restored *Granularia* to its proper place in 1891. Roth* himself described and figured two species six years later under the name of *Cyathus farctus*, and *Cyathus scutellaris*; it is possible that these belong to our genus *Nidula*, but with the imperfect descriptions it is difficult to determine. It is very evident that they are not species of *Cyathia*.

Bulliard,† in 1780 made the first mention of the name *Nidularia*, but he referred it to figures which have been unquestionably proved to be *Cyathia lentifera* and *Crucibulum crucibuliforme*. Sibthorp‡ also employed this name for *Cyathia lentifera*, *Cyathia hirsuta* and *Crucibulum crucibuliforme*. In 1817 Nees§ described and figured *Nidularia granulifera*, but although he gives a colored plate, it is difficult to form a correct idea of his plant. Two years later Ehrenberg|| described and figured *Nidularia globosa* which he says resembles *Cyathus farctus* Roth and *Cyathus deformis* Willd.¶ but agrees with neither. About this time, 1818, Schweinitz described from North Carolina *Cyathus pulvinatus*, which, though unfortunately none of the original material remains except some of the wood on which it grew, is evidently a true *Granularia* and is a fairly common species in our own country, and the only clear and definite one of the whole tangled thread of the present history.

The family Nidulariaceae was established by Fries in 1822. Under the section "*Nidularia*," he gives seven species, five of which are the above-quoted ones of Nees, Schweinitz, Roth, Ehrenberg and Willdenow; the last one, *Nidularia denudata* Fr. & Nordh. ** appears from the description to be a true *Granularia*, while the third species which he gives as *Nidularia farcta* he refers to Ray's †† no. 21, which is the first mention of *Crucibulum crucibuliforme*.

* Cat. Bot. 1: 237. pl. 7. f. 2. 1797.

† Herb. Fr. pl. 488.

‡ Flor. Ox. 393. 1794.

§ Syst. Pilze. 139 note. pl. 13. f. 133c. 1817.

|| Sylv. Myc. Berol. 16, 28. f. 8. 1819.

¶ Ust. Bot. Mag. 2: 14. pl. 5. f. 8. 1788.

** Symb. Gaster. 4. 1817-18.

†† Syn. 20. pl. 1. f. 2.

Fischer * in writing of *Nidularia* says that there are sixteen known species, but though De Toni † gives eighteen from all parts of the world, it is more than probable that several of these are either synonyms of other species or belong to other genera. Tulasne gives eleven species, to nine of which he adds "non vidimus"! the remaining two being new species—*Nidularia australis* from Chili, South America, and *Nidularia Duriacana* from LaCalle, Algeria (Mauritania). From America several additional species have been described, namely, *Nidularia Alabamensis* Atk. ‡ from Alabama, which we have reduced to *Granularia pulvinata*, and *Nidularia rubella* E. & E. § from New Jersey. This last species is very uncertain, in fact it may not belong to this family at all, as the sporangioles are quite different in texture from those of all the other species, and have never been found to contain any spores, being filled with small pieces of amorphous hyaline matter. It is hard to believe that the plants are in an immature condition as the peridial walls have in some specimens almost entirely disappeared. The only remaining species of *Nidularia* which has been described in this country is *Nidularia candida* Peck which has been referred to the preceding genus. Two heretofore unpublished species of *Granularia* complete our present list: *Granularia castanea*, a herbarium species of Ellis & Everhart, under the name of *Nidularia castanea*, from New Jersey found in 1883, and *Granularia rudis* Peck, from California.

Synopsis of the Species of *Granularia*

Sporangioles numerous, small (1 mm. or less in diameter).

Peridium tubercular, pulverulent.

1. *G. pulvinata*.

Peridium only slightly tubercular, not pulverulent.

2. *G. castanea*.

Sporangioles few, larger (2 mm. or more in diameter).

3. *G. rudis*.

1. GRANULARIA PULVINATA (Schwein.) Kuntze, Rev. Gen. Pl.

2: 855. 1891

Cyathus pulvinatus Schwein. Fung. Car. Sup. 51. 1818.

Nidularia pulvinata Fries, Syst. Myc. 2: 301. 1822; Schwein.

Trans. Am. Phil. Soc. 4: 253. 1834.

* Engler & Prantl. Nat. Pflanzenfam. 11** : 326. 1899.

† Saccardo. Syll. Fung. 7: 28. 1888;—9: 265. 1891;—11: 156. 1895;—14: 256. 1899.

‡ Bull. Cornell Univ. (Science) 3: 23. 1897.

§ Bull. Torrey Club, 11: 18. 1884.

Nidularia Alabamensis Atk. Bull. Cornell Univ. (Science) 3: 23
1897.

Peridia subspherical, sessile, 2–10 mm. wide, 2–9 mm. high, reddish-brown or dirty cinnamon-colored, at first very floccose-pulverulent, gradually becoming smoother with age, dehiscing irregularly or not at all; peridium thin and rather brittle, tuberculose; inner surface is shiny, smooth, brownish; sporangioles very numerous, darkish brown, barely 1 mm. in diameter, somewhat angular and depressed; spores hyaline, thick-walled, 6–10 μ long, 4–7 μ wide. (Pl. 17. f. 10–16, 20; Pl. 18. f. 19.)

Plants gregarious, rarely singly on wood.

NEW YORK: *Ellis, Fairman, Kupfer*; LOUISIANA: *Langlois*, 2666 and 1821; CONNECTICUT: *White*; MAINE: *Harvey*; ALABAMA: Auburn, *Atkinson*.

The floccose pulverulent appearance of the surface of the peridium is caused by the innumerable ends of the filaments which compose the peridium protruding above the main structure, soon becoming broken or eroded. This is a very characteristic feature which renders this species easily recognizable.

Atkinson (*l. c.*) describes *Nidularia Alabamensis*, which undoubtedly belongs here substantially as follows: Peridia spherical, sessile, reddish-brown, roughened, 4–5 mm. in diameter, irregularly dehiscing by the breaking into fragments of the upper portion exposing the sporangioles which completely fill it; no "rooting" threads; sporangioles lenticular, shiny, dark or blackish-brown, barely 1 mm. in diameter, corrugated, hard, filled with a whitish pulpy material which is composed of stout irregular flexuous or blanched knotty strongly tuberculose threads with which the spores are mixed; the spores are obovately hyaline, 4–6 $\times$ 3–4 μ .

On decaying wood.

ALABAMA: Auburn, July, 1890.

2. *Granularia castanea* (Ell. & Ev.) sp. nov.

Nidularia castanea Ellis & Everhart in herb.

Peridia small, elongate-globose, or subspherical, sessile, sometimes confluent, .5–2 mm. long, 0.5–1 mm. high; peridial walls very thin, and brittle at first, pale yellowish fawn-colored, gradually as the plant matures becoming grayish, and somewhat tuberculose from the inner pressure of the sporangioles, dehiscing irregularly, the outer covering often breaking away completely,

leaving the sporangioles seated alone on the wood, barely visible without magnification; sporangioles yellowish-brown, very numerous, crowded, circular, flattened above and below, barely 0.25 mm. in diameter, even or slightly creased under high magnification; spores subglobose, hyaline, thick-walled, 4-7 μ long, 3-6 μ wide. (*Pl. 17. f. 17-19; pl. 18. f. 20.*)

Gregarious on wood.

NEW JERSEY: Newfield, July, 1883. *Ellis.*

3. *Granularia rudis* Peck sp. nov.

Peridia hemispherical or subglobose, sessile; outer covering thin, smooth, fragile when dry, cellular, rather gelatinous when moist, yellowish-brown with a faint greenish tint; indehiscent or the peridial walls gradually breaking away; sporangioles few, irregular, angular or compressed, 2-2.3 mm. in diameter, blackish or greenish tinted; spores broadly elliptic or subglobose, hyaline, 7-9 μ long, 6-8 μ broad. (*Pl. 17. f. 21-23.*)

On decaying wood.

CALIFORNIA: *W. R. Dudley.*

The material from which this species is described is very scanty, but the specific features are so individual, and they differ so much from any known species of *Granularia* that it has been decided to include it in the present revision. It differs from all known species in the gelatinous cellular and greenish texture of the peridium, and in the large angular sporangioles, only a few being contained in each peridium.

SPECIES INQUIRENDA

NIDULARIA RUBELLA Ell. & Everh. Bull. Torrey Club, 11: 18. 1884.

The following table will show the present known distribution of the family in North America :

Explanation of Plates

The figures on Plates 14, 15, 16 and 17 were drawn one quarter larger than indicated. Those on Plate 18 were made twice the size. The microscopic details were drawn with a camera lucida and reduced on the same scale, as above noted.

PLATE 14

FIG. 1. *Cyathia Poeppigii*, nat. size. 2. The same, enlarged about three times after moistening. 3. Single peridium in dry condition. 4. Spores, $\times 335$. 5. *Cyathia Berkleyana*, nat. size. 6. Peridium of same, enlarged three times. 7. Spores, $\times 335$. 8. *Cyathia intermedia*, nat. size. 9. Peridia, enlarged twice, one in dry condition, the other after expanding when moistened. 10. Spores, $\times 335$. 11. *Cyathia hirsuta* nat. size. 12. Group, enlarged about three times. 13. Spores, $\times 335$. 14, 15. *Cyathia hirsuta infundibuliformis*, enlarged about three times. 16. *Cyathia dura*, nat. size. 17, 18. Peridia, enlarged twice. 19. Spores, $\times 335$. 20. *Cyathia Montagnei*, nat. size. 21. Peridium, enlarged twice. 22. Spores, $\times 335$.

PLATE 15

FIG. 1. *Cyathia melanosperma*, nat. size. 2. Single peridium, nat. size (after moistening). 3. Single peridium, enlarged about three times. 4. Spores, $\times 335$. 5. *Cyathia pallida*, nat. size. 6. Mature and young peridia, enlarged twice. 7. Spores, $\times 335$. 8. *Cyathia lentifera*, nat. size. 9, 10, 11, 12. Different specimens showing character of growth and shape, enlarged twice. 13. Spores, $\times 335$. 14. *Cyathia rufipes*, nat. size. 15. Peridia, enlarged twice. 16. Spores, $\times 335$. 17. *Cyathia stercorea*, nat. size. 18, 19. Different specimens showing character of growth and shape, enlarged about three times. 20. Spores, $\times 335$.

PLATE 16

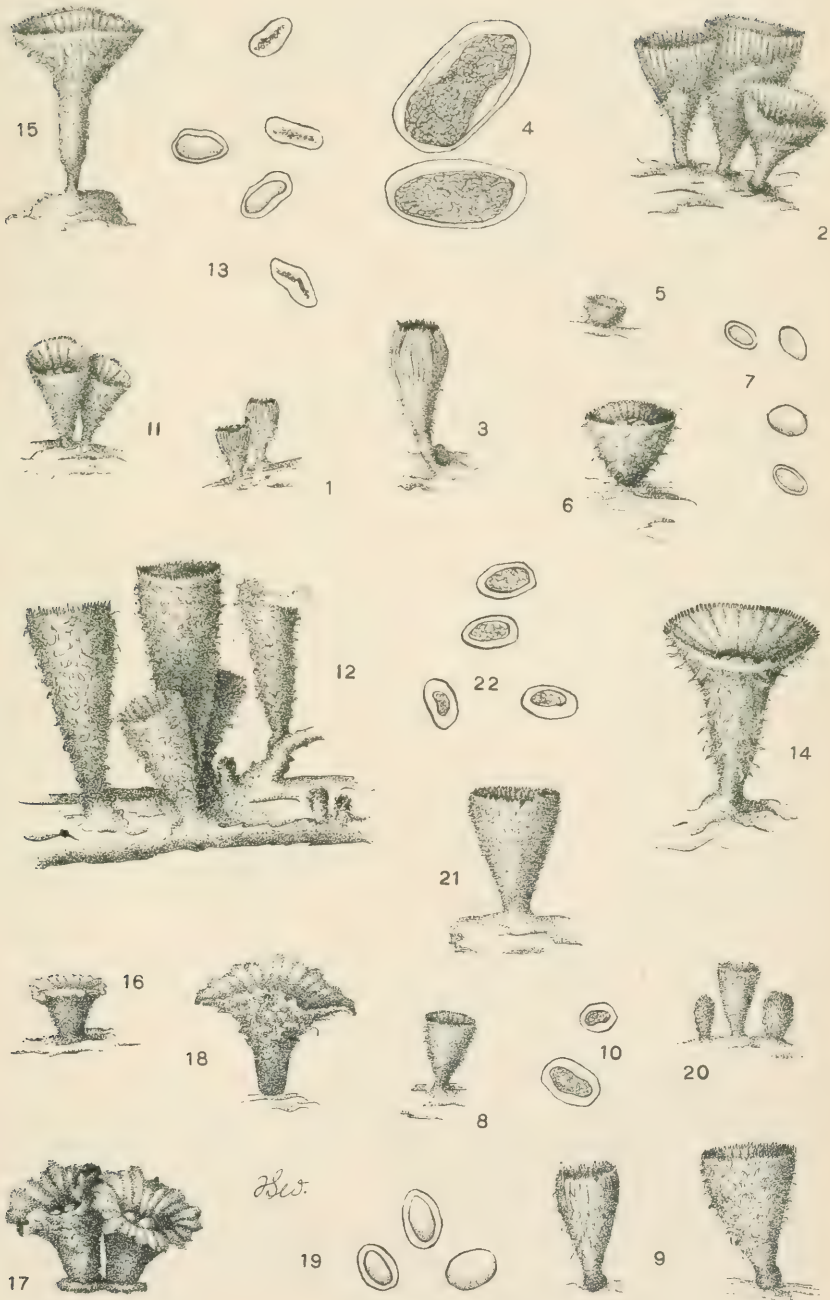
FIGS. 1, 2. *Cyathia stercorea*, showing additional types and characteristics, enlarged twice. 3. *Cyathia rugisperma*, natural size. 4. Peridia enlarged twice. 5. Spores, $\times 335$. 6. Spores, $\times 585$. 7. *Cyathia Wrightii*, natural size. 8, 9. Peridia, enlarged twice. 10. *Crucibulum crucibuliforme*, natural size. 11. Section of sporangiole, $\times 50$. 12. Group of peridia, enlarged twice. 13. Spores, $\times 335$. 14. Group of peridia from the Schweinitz specimens of *Crucibulum juglandicolum*. 15. Spores from the same, $\times 335$. 16. *Cyathia* (?) sp., natural size. 17. *Nidula candida*, natural size. 18, 19. Peridia, somewhat enlarged. 20. Spores and filament, $\times 335$. 21, 22. Spores of *Cyathia* (?) sp., $\times 335$.

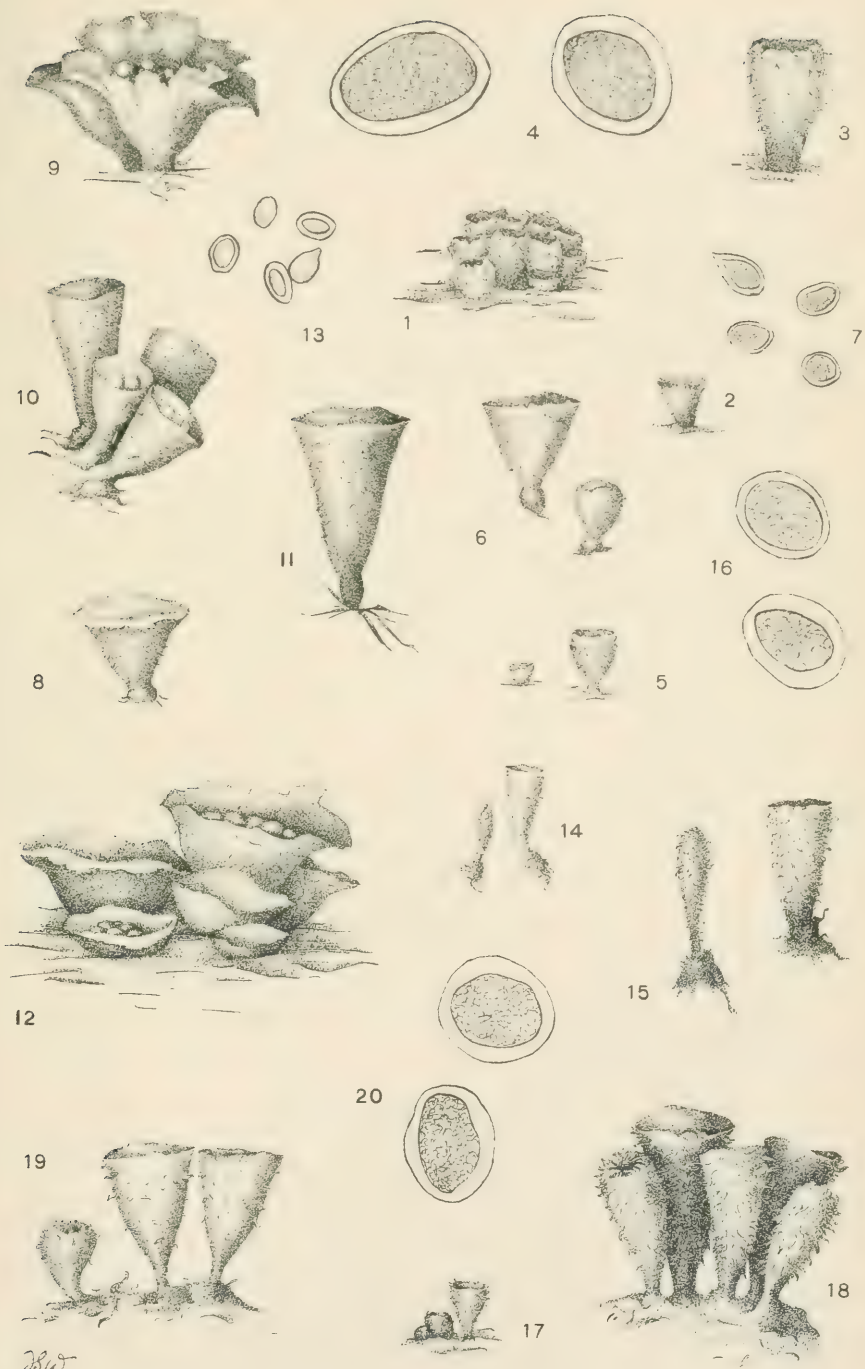
PLATE 17

FIG. 1. *Nidula microcarpa*, nat. size. 2. Peridia, enlarged twice. 3. Section-enlarged about five times. 4. Sporangiole showing torn outer covering, enlarged about twenty-five times. 5. Sporangiole still in its outer covering, enlarged twelve times. 6. Spores, $\times 335$. 7. *Nidula microcarpa rugispora*, nat. size. 8. Peridium, enlarged three times. 9. Spores, $\times 335$. 10. *Granularia pulvinata*, nat. size, reduced from drawing by Mr. Hasselbring of *Nidularia Alabamensis* Atk. 11. *Granularia pulvinata*, nat. size. 12. Peridia, enlarged three times. 13. Spores and filaments, $\times 335$. 14. Very old peridia, the walls of which have almost completely fallen away. 15. Spores. $\times 585$. 16. Spores, $\times 335$. 17. *Granularia castanea*, nat. size. 18. Group of peridia, enlarged twice. 19. Irregular peridia, having grown together, enlarged twice. 20. Spores of *Granularia pulvinata*, $\times 335$ (*Nidularia Alabamensis* Atk.). 21. *Granularia rudis*, enlarged twice. 22. Spores, $\times 335$. 23. Sporangioles, $\times 15$.

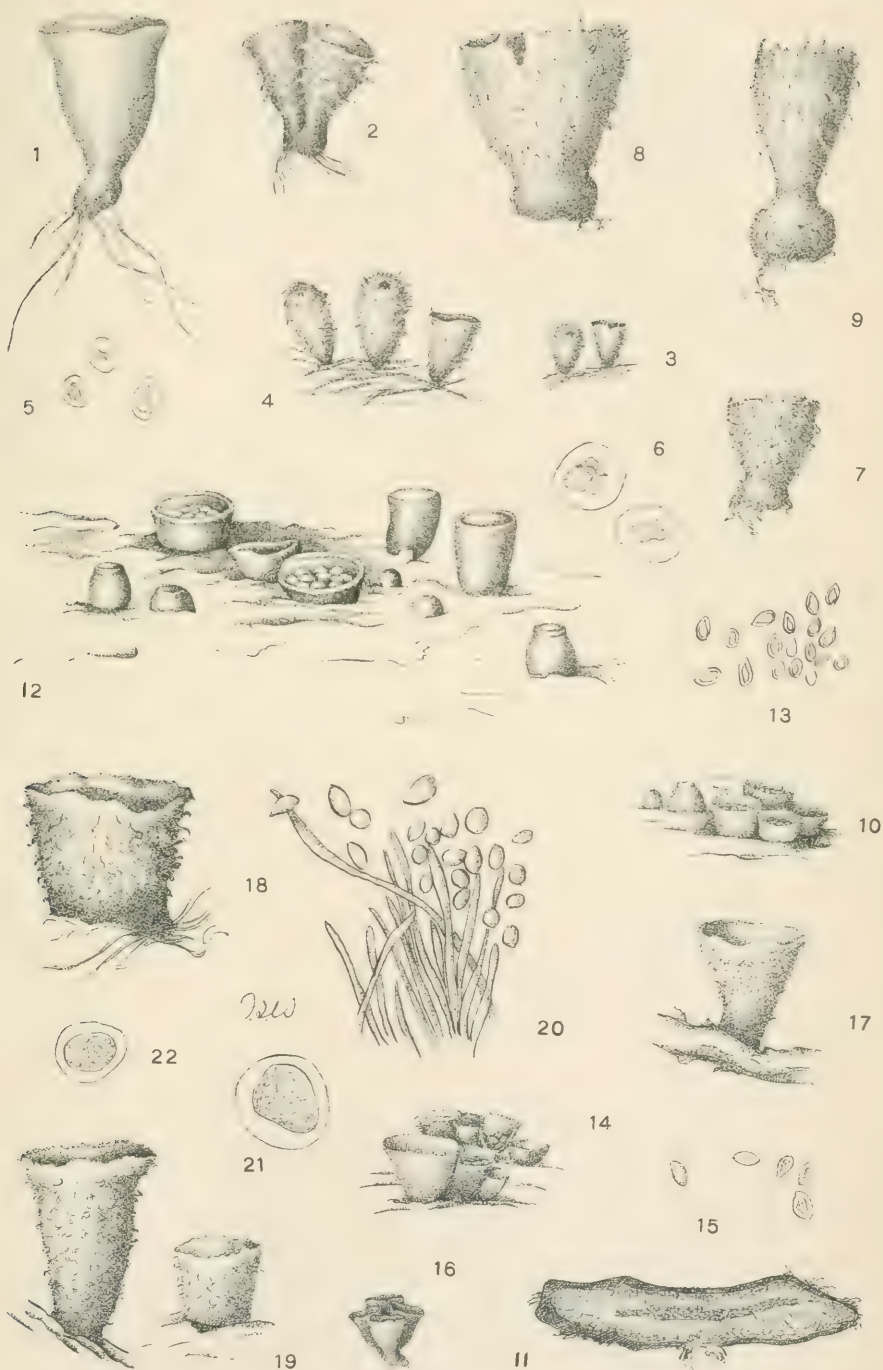
PLATE 18

FIGS. 1-6. *Cyathia hirsuta*. 1. Sporangiole, showing attachment, enlarged about fifteen times. 2. Spore, $\times 390$. 3. Spores and filaments, $\times 215$. 4. Threads of outer coating of sporangiole, $\times 215$. 5. Nodose filaments of the funiculus, $\times 390$. 6. Portion of the funiculus, $\times 110$. 7-13. *Crucibulum crucibuliforme*. 7. Sporangiole, $\times 15$. 8. Sporangiole, with the outer coat peeling off. 9. Small portion of a section of a sporangiole, $\times 215$. 10, 11. Spores of young specimen, $\times 390$. 12. Spores of fully mature specimen, showing contraction of inner substance, $\times 390$. 13. Small portion of the ends of the filaments of the thin membrane covering the mouth of the immature specimen, $\times 315$. 14. Spores of *Nidula microcarpa*, $\times 390$. 15. Lateral portion of outer coat of the sporangioles of same, $\times 215$. 16. Small portion of the outer coat of the sporangiole of *Crucibulum crucibuliforme*, $\times 215$. 17. Section of a sporangiole of *Nidula microcarpa*, $\times 110$. 18. Fascicular hairs from the outer covering of the peridium of *Cyathia intermedia*, $\times 15$. 19. Small portion of the peridial wall of *Granularia pulvinata*, $\times 215$. 20. Sporangioles of *Granularia castanea*, when devoid of peridial covering, $\times 110$.





CYATHUS.



CYATHUS, CRUCIBULUM, NIDULA.



NIDULA, GRANULARIA.



CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 25

NOTES ON AMERICAN HEPATICAE

BY MARSHALL A. HOWE.

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Notes on American Hepaticae

BY MARSHALL A. HOWE

I. CEPHALOZIA CONNIVENS

CEPHALOZIA CONNIVENS (Dicks.) Lindb. Proc. Linn. Soc. **13**: 190. 1872. Kritisk Gransk. Mossorna Dill. Hist. Musc. 38. 1883. Spruce, On Cephalozia, 46. 1882. Lindb. & Arn. Sv. Vet.-Akad. Handl. **23**⁵: 20. 1889. Kaalaas, Nyt Mag. 165. 1893.

Jungermannia connivens Dicks. Fasc. Pl. Crypt. Brit. **4**: 19. pl. 11. f. 15. 1801.

Cephalozia multiflora Lindb. Act. Soc. Sci. Fenn. **10**: 501. 1875. Musc. Scand. **4**. 1879.

This species has been much confused with its near relative *Cephalozia lunulacfolia* Dumort. (*C. media* Lindb., *C. multiflora* Spruce) both in Europe and America, but is very distinct as was first well pointed out by Spruce (*On Cephalozia*, 39. 1882). The plant may be readily distinguished from *C. lunulacfolia* by the large leaf-cells (35–90 μ , while only 25–50 μ in *C. lunulacfolia*), by the long-ciliate perianth-mouth, by the perianth-wall being unistratose throughout, and by being autoicous. The specimens distributed by Sullivant under the name of *Jungermannia connivens* in Musci Alleghanienses (no. 246) belong with *C. lunulacfolia* so far as we have been able to see them, and the same is true of no. 57 of Austin's Hepaticae Boreali-Americanae, issued as *Cephalozia connivens*. In 1896, Professor Underwood, in his review of "The Genus *Cephalozia* in North America" (Bull. Torrey Club, **23**: 381–394), placed *Cephalozia connivens* under "Species dubiae et inquirendae," remarking that it was likely to occur northward. In October, 1898, the writer of the present notes announced* at a meeting of the Torrey Botanical Club the discovery of the genuine *Cephalozia connivens* on the grounds of the New York Botanical Garden, supposing this to be the first collection of the real *C. connivens* in America. The species was soon found in several other places in the neighborhood of New York, and this has led to an

* Bull. Torrey Club, **26**: 24. 1899.

examination of the specimens of *Cephalozia* in the accessible herbaria with the result that we are now able to cite seventeen North American specimens of the true *Cephalozia connivens*, showing a coastwise range from Prince Edward Island to Florida, and an extension inland as far as London, Ontario.

The specimens cited may be arranged as follows:

PRINCE EDWARD ISLAND: *J. Macoun*, June 27, 1888, no. 139 (a little only, mixed with *C. lunulacifolia* and *Kantia trichomanis*). ONTARIO: London, *J. Dearness* (in herb. Underwood, comm. in 1889 as no. 1). RHODE ISLAND: Providence, from Olney collection in Chapman herbarium; also, in same herbarium, a second specimen from Rhode Island, without locality. CONNECTICUT: on the ground in wet woods, Westville, *A. W. Evans*, November 29, 1890. NEW YORK: in a tamarack swamp, Syracuse, *L. M. Underwood*, April, 1888; Staten Island, *Mrs. E. G. Britton*, February 14, 1892; on the top of a decayed hemlock stump near Bronx River, New York Botanical Garden, *M. A. Howe*, September 21, 1898, with *Odontoschisma sphagni*; on bank of a stream in a boggy wood, Freeport, Long Island, *M. A. Howe*, October 17, 1898; on margin of a swamp, Richmond, Staten Island, *M. A. Howe*, October 23, 1898; Sayville, Long Island, *F. E. Lloyd*, March 5, 1899. DELAWARE: on ground in woods, Wilmington, *A. Commons*, March 12, 1890; in herb. Columbia University. NORTH CAROLINA: Salem, *Schweinitz*, in herb. Torrey (labelled *Jungermannia bicornis* by Schweinitz). SOUTH CAROLINA: Summerville, *C. G. Dubois*, April, 1889. FLORIDA: Lisbon, *L. M. Underwood*, January, 1891 (distributed from U. S. National Herbarium as no. 1217); Port Orange, *F. C. Straub*, February 23, 1895 (no. 207 in herb. Underwood)—also in same locality, March, 1895, mixed with *Telaranea* and a minute *Lepidozia* in Hepaticae Americanae, no. 180. BERMUDA: Devonshire Marsh, *M. A. Howe*, July 4, 1900.

Lindberg appears to have been the first to have combined the specific name *connivens* (Dicks.) with the generic name *Cephalozia*, although at the outset he attributed the binomial to Dumortier. Dumortier however persisted even in his "Hepaticae Europae" in keeping the species under *Blepharostoma* and seems never to have written *Cephalozia connivens*. The synonymy of the species is

confused, owing partly to the fact that it was not until 1881 and 1882 that Lindberg and Spruce began to distinguish, in their published works at least, between the true *Cephalozia connivens* and *C. lunulacfolia*, and owing furthermore to some uncertainties attending the determination of *Jungermannia multiflora* of Hudson (Fl. Angl. 431. 1762). The question of interpreting correctly Hudson's *J. multiflora*, difficult at best, is needlessly complicated by Dr. Spruce (*l. c.* 40) by quoting the 1778 edition of Hudson's *Flora Anglica*, where a supposed synonym from Linné's *Mantissa* is introduced, though the original 1762 edition without the Linnaean synonym is all that needs to be considered. The original *Jungermannia multiflora* seems to have been founded wholly upon a plant described and figured by Dillenius (*Hist. Musc.* 481. *pl.* 69. *f.* 4. 1741). As noted already by Hooker, Spruce, and Lindberg, the figures given by Dillenius point strongly to *Cephalozia bicuspidata*. It is quite impossible to believe that they were drawn from specimens of *C. connivens* and Dillen's words "*per lentem vero perangusta*" in describing the leaves could not well apply to this species, yet Lindberg in 1875 (*Act. Soc. Sci. Fenn.* 10: 501), after determining the specimen in the Dillenean herbarium bearing the corresponding name and number from the *Historia Muscorum* to be the *Jungermannia connivens** of Dickson, brought forward for this species Hudson's name *multiflora*. Finally,† however, interpreting this "*Lichenastrum multiflorum exile foliis angustissimis*" of Dillenius by the figure and description, Lindberg considers it a synonym of *Cephalozia bicuspidata* (L.) Dumort., which seems to us the most reasonable course in the matter. Lindberg at the same time most unwarrantably interprets *Jungermannia multiflora* Huds. in the light of additions made by Linnaeus nine years after its original publication and shifts the specific name *multiflora* to *Lepidozia setacea* (Web.) Mitt. It is clear that if *Jungermannia multiflora* Huds. (1762) can be justly treated as a synonym of *J. bicuspidata* L. (1753) it should always remain a "dead name."

* This determination, it may be noted, was made several years before the distinctions between the true *C. connivens* and *C. lunulacfolia* (*C. media* Lindb.) were recognized in print, at least, yet the statement that the Dillenean specimen is "*C. connivens* (Dicks.) Lindb.," was repeated by Lindberg in 1883, two years after his publication of *C. media*.

† Kritisk Gransk. Mossorna Dill. *Hist. Musc.* 38. 1883.

II. TELARANEA

TELARANEA Spruce, Trans. and Proc. Bot. Soc. [Edinb.] 15: 365. 1885. [As a synonym.] Schiffn.; Engl. & Prantl, Nat. Pflanzenfam. 1³: 103. 1895.

The genus *Telaranca* has points of contact with *Lepidosia*, *Blepharostoma*, and *Arachniopsis*, and if generic rank is denied to it, might be incorporated with any one of the three with almost equal justice. To the *Micro-Lepidosia* section of the genus *Lepidosia* its affinity is perhaps especially close, yet, according to prevailing conceptions of genera among the Hepaticae, it seems a rather violent proceeding to include it in a generic group the historical type of which is *Jungermannia reptans* L. *Telaranca* diverges from *Lepidosia* in its delicate, filmy, conferva-like habit and in the division of the leaves very nearly or quite to the base, the segments being never more highly connate than through half the altitude of the basal cell and usually for a considerably less distance; the leaf-segments are capillary, of a single row of cells unless at the very base, the place of the basal cell being often occupied by a pair of cells side by side. From *Blepharostoma*, *Telaranca* is probably best distinguished by the disparity in size between leaves and underleaves and by the more pinnate branching. The archegonia, though usually borne on short postical branches as in *Lepidosia* and *Cephalozia*, are sometimes terminal on the main stem or lateral branches as in *Blepharostoma*.

In its filmy habit and delicacy of structure *Telaranca* is suggestive of *Arachniopsis* Spruce, but the latter genus represents a still further departure along the same lines from the *Lepidosia* type. In *Arachniopsis* the branches are all postical in origin, the underleaves are entirely wanting or are now and then to be recognized only in a most rudimentary form, and the leaves never have more than two segments which are wholly free at the base and consist of a single series of cells throughout.

The species and varieties to be arranged under the genus are, so far as we know them, as follows:

1. *Telaranca nematodes* (Gottsche)

Jungermannia nematodes Gottsche, Hepaticae Cubenses Wrightianae.

Cephalozia nematodes Aust. Bull. Torrey Club, 6: 302. 1879.

Lepidozia chaetophylla Spruce, Trans. and Proc. Bot. Soc. [Edinb.] 15: 365. 1885.

Lepidozia nematodes Spruce, *l. c.* 366.

Telaranea chaetophylla Spruce, "Mst. nov. gen." *l. c.* [as synonym]. Schiffn. ; Engl. & Prantl, Nat. Pflanzenfam. 1³: 103. 1895.

Lepidozia chaetophylla tenuis Pearson, Christ. Vid.-Selsk. Forhandl. 1886³: 9. 1886. Evans, Bull. Torrey Club, 20: 308. 1893.

Blépharostoma nematodes Underw. Bull. Torrey Club, 23: 383 (footnote). 1896.

Spruce in comparing his *Lepidozia chaetophylla* with *Lepidozia nematodes* (Gottsche) emphasizes the flaccidity of the latter as a distinguishing character and this indeed appears to be about the only difference of importance to be detected between Wright's Cuban plant and those from South America distributed by Spruce as *Telaranea chaetophylla* (Hepaticae Spruceanae: Amazonicae et Andinae). Wright's specimens revive quite imperfectly on being soaked out with water, but there is such a range of variability in this respect in different parts of a single tuft and even of different parts of a single plant, both in the Cuban and South American specimens that we are not inclined to give much weight to this character. We therefore agree with our friend Mr. Pearson (*l. c.*) in believing that the two forms represent a single species. We would, however, differ from Pearson in retaining for this species the oldest published name *nematodes*. The specific name *nemoides* given earlier by Taylor to another plant now recognized as a *Lepidozia* seems sufficiently different both to the eye and ear to prevent confusion.*

In both the Cuban and South American plants the archegonia are usually borne on a short postical branch, rarely at the end of the main axis or of an elongated branch. In 1886, Pearson (*l. c.*) identified a specimen from Natal, South Africa, with Gottsche's Cuban species, which he renamed *Lepidozia chaetophylla tenuis*.

*The remark is attributed to Spruce (Pearson, *l. c.*) that *nemoides* and *nematodes* differ only in case-ending. It seems to us that the two words are equally nominative in form but that Taylor's name *nemoides* is an etymological monstrosity on account of his failure to use the true stem of the Greek noun in constructing the adjective.

Through the courtesy of Mr. Pearson we have been able to examine this South African plant, and like him, can find no reasonable grounds for distinguishing it from the American specimens alluded to. *Telaranea nematodes*, then, may be said to be found in a fairly typical condition in South America and South Africa as well as in Cuba, and to this range is now to be added Bermuda, where sterile plants were collected by the writer in Devonshire Marsh, July 4, 1900, growing in company with *Cephalozia connivens* and *C. divaricata*. In addition to this more or less typical form, illustrated by the specimens and descriptions cited, the species presents itself also in two forms which we think are sufficiently marked to receive varietal names. These are:

1a. ***Telaranea nematodes Antillanum*** (Besch. & Spruce)

Blepharostoma Antillanum Besch. & Spruce, Bull. Soc. Bot. France, 36: clxxxiii. 1889.

Archegonia terminal on main stem, a lateral branch, or elongated postical branch, rarely on a short postical branch; leaves and perianth rather rigid.

Le Gommier, Gaudeloupe, *Ed. Maric*. In a specimen of the Guadeloupe plant kindly communicated by M. Bescherelle we find on a single individual all the various modes of bearing archegonia described above. The leaves, described by the authors as 4-parted, we find much more frequently 3- and 2-parted. It seems as impossible to separate this plant specifically from *Lepidozia chaetophylla* Spruce as it is to distinguish satisfactorily between the latter and Gottsche's *Jungermannia nematodes*. So far as we know, the identification of *Blepharostoma Antillanum* with *Jungermannia nematodes* was first made by Professor Schiffner (Engl. & Prantl, Nat. Pflanzenfam. 1³: 105. 1895).

1b. ***Telaranea nematodes longifolia*** var. nov.

Leaves more rigid than in type and more widely spaced, 0.4–0.8 (rarely 0.9 mm.) long, leaf-cells 2–4½ times as long as broad.

Collected by the writer on humus in a swampy wood in company with *Sphagnum*, *Pallavicinia Lyellii*, and *Cephalozia catenulata*, Freeport,* Long Island, New York, October 17, 1898

* This Freeport plant was listed by Dr. Smith Ely Jelliffe in his Flora of Long Island (48. 1899) under the name *Blepharostoma nematodes*.

(type specimen in herb. N. Y. Botanical Garden). Also, Florida, *John Donnell Smith*, 1877; *C. F. Austin*, March, 1878; *F. C. Straub*, March, 1895; Brunswick, Georgia, *C. F. Austin*, April, 1878.

The Long Island specimens agree essentially with those from Georgia and Florida, though the latter make a slightly closer approach to the Cuban plant. The Long Island station is therefore a noteworthy northward extension of the known range of a plant which has heretofore figured in papers on North American Hepaticae as coming only from a limited region of the South. The archeogonia in these United States specimens, so far as we have observed, always occur on a short postical branch. The leaves are 5-8 cells long; the underleaves are 3- or 2-parted, their prongs of 2 or 3 cells each, incurved at the apices. All are autoicous. In the original *Jungermannia nematodes*, collected in Cuba by Wright, the leaves are 0.25-0.5 mm. long, 4-6 cells high, the cells being 2-3 times longer than broad.

The variety *longifolia* often gives the impression of being two or three times the size of the Cuban plant, but we have been unable to find any reliable structural characters to serve for a specific separation. The form of the perianth seems quite variable in all conditions of the species, but is often broader in the var. *longifolia* than in the type.

No. 180 Hep. Am., issued as *Blepharostoma nematodes*, is referable to *Telaranea nematodes longifolia*; it is mixed with *Cephalozia connivens* and with a minute *Lepidozia*, probably a reduced form of *L. setacea*.

***Telaranea bicruris* (Steph.)**

Lepidozia bicruris Steph. Hedwigia, **24** : 166. pl. 3. 1885.

BRAZIL : São Francisco, *Ule*.

This plant, though a close relative of *T. nematodes*, seems entitled to specific distinction, differing in the almost invariably 2-parted leaves, in the frequent continuation of the stems into leafless flagella (rare in *T. nematodes*) and in the simpler ♀ bracts. It is described by Stephani as dioicous, though apparently he had not seen ♂ plants. We have been unsuccessful in attempts to find antheridia in the specimen kindly communicated by Herr Stephani, and it certainly may be suspected that dioicism is to be

added to its distinguishing characters. All the perianths seen are on very short postical branches.

III. ARACHNIOPSIS

Arachniopsis diacantha (Mont.)

Jungermannia diacantha Mont. Ann. Sci. Nat. IV. 5: 349. 1856.

Arachniopsis coactilis capillacea Spruce, On Cephalozia, 85. 1882; Trans. and Proc. Bot. Soc. [Edinb.] 15: 356. 1885.

Leaves mostly rigid, composed of 4-6 cells, these 4-7 times as long as broad.

PERU: *Weddell, Spruce.*

Jungermannia diacantha Mont. is represented in the Montagne herbarium, now preserved in the Muséum d'Histoire Naturelle of Paris, only by two small sterile fragments fastened to pieces of mica. This original material, which we have seen through the courtesy of Mons. Hariot, agrees perfectly, so far as it goes, with the specimen from Mt. Campana, Peruvian Andes, distributed by Spruce as *Arachniopsis capillacea* in his "Hepaticae Spruceanae: Amazonicae et Andinae." Montagne's description of the leaves as "spiraliter 5/1 circa caulem dispositis" was evidently an error, due, it may be, to a torsion of the stem.

Arachniopsis confervifolia (Gottsche)

Jungermannia confervifolia Gottsche, Hepaticae Cubenses Wrightianae.

Cephalozia confervifolia Aust. Bull. Torrey Club, 6: 302. 1879.

Arachniopsis coactilis Spruce, On Cephalozia, 85. 1882. Trans. and Proc. Bot. Soc. [Edinb.] 15: 355. *pl.* 13. 1885. Excluding var. *capillacea*.

Leaves often flaccid, composed of 6-14 cells, these 2-3 times as long as broad.

CUBA: *Wright*; SOUTH AMERICA: on the tributaries of the Amazon, *Spruce*. We have little hesitancy in considering *Arachniopsis coactilis* Spruce a synonym of the Cuban *Jungermannia confervifolia* Gottsche. The latter is more flaccid, showing a relation to the South American specimens somewhat analogous to that

described above as existing between *Jungermannia nematodes* Gottsche and *Lepidosia chaetophylla* Spruce. The Cuban plant is autoicous and in structural characters is essentially identical with the typical *A. coactilis*. Vestiges of underleaves are occasionally met with in both and in both the leaf is sometimes reduced to a single prong.

The specific separation of *Arachniopsis confervifolia* from *A. diacantha* is possibly open to question, yet in the light of available specimens the two appear distinct. *Arachniopsis coactilis filifolia* Spruce, judging from specimens distributed as *Arachniopsis filifolia* in Hepaticae Spruceanae, seems to us less entitled to specific rank.

Arachniopsis confervifolia resembles *Telaranca nematodes* in outward appearance, but is easily distinguished by the characters alluded to above under *Telaranca*. It is to be expected that *Arachniopsis* will be found to occur within the limits of the United States.

IV. RICCIA CAMPBELLIANA

Herr M. Heeg, of Vienna, has kindly called our attention (*in litt.*) to the close resemblance between the Californian *Riccia Campbelliana* M. A. Howe (Mem. Torrey Club, 7: 26. pl. 91. f. 1-15. 1899) and the Mediterranean *Riccia macrocarpa* Levier (Bull. Soc. Bot. Ital. 1894: 114. 1894). The similarity is indeed very striking as is evident from specimens of *R. macrocarpa* which we owe to Dr. Levier, but *R. macrocarpa* appears to be uniformly dioicous as originally described by Levier and as described again by Stephani (Bull. Herb. Boiss. 6: 343. 1898), while *R. Campbelliana* is uniformly monoicous; and the areolae of the outer face of the spores of *Riccia macrocarpa* are more perfect than in *R. Campbelliana*. In view of these differences the claim of *Riccia Campbelliana* to specific rank seems defensible for the present at least. The species has recently been collected by Dr. Walter R. Shaw at Claremont, Los Angeles County, Cal., thus extending its known range about two hundred and fifty miles southward.

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